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PROGRESS REPORT No.

XV-5A

LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRA

CONTRACT NUMBER DA44-177-TC-715

GENERAL ELECTRIC

XV-5A LIFT FAN
FLIGHT RESEARCH AIRCRAFT

Contract No. DA44-177-TC-715

QUARTERLY TECHNICAL PROGRESS REPORT NO. 8

For Period August 16, 1963 to November 15, 1963.

ADVANCED ENGINE AND TECHNOLOGY DEPARTMENT
GENERAL ELECTRIC COMPANY
Cincinnati 15, Ohio

ABSTRACT

SECTION A - PROPULSION

During the eighth quarter the manufacture and acceptance testing of propulsion system was completed. Propulsion system support was expanded during the aircraft ground tests. Flight test program details and a revised program schedule were completed and submitted to TRECOM. Full scale wind tunnel test preparations are well underway with the necessary test hardware and instrumentation being manufactured.

SECTION B - AIRPLANE

Static structural tests and ground resonance tests of the aircraft were completed. Numerous structural stress, and model test reports were completed and issued. Installation of all aircraft electrical and hydraulic components has been made in the simulator with approximately 30 hours operating time. Installation of systems is progressing on both aircraft with No. 1 aircraft 92% complete and No. 2 aircraft 94% complete.

SECTION A. PROPULSION

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I. SUMMARY

During the eighth quarter (August 16, 1963 to November 15, 1963) progress under the propulsion system program included:

* Acceptance testing completed on two lift fans and one pitch fan.
* Two J85 engines updated to J85-5B configuration
* Four spare J85-5A engines received
* Flightworthiness Penalty Test Report completed and submitted to TRECOM.
* Revised Plan For Performance completed and submitted to TRECOM.
* Detailed Flight Test Program completed and submitted to TRECOM.
* PCM data acquisition system accepted for installation into the aircraft.
* Design of full scale wind tunnel test plans, instrumentation, actuation and controls completed. Manufacture of the necessary test equipment has begun.

II. DESIGN AND ENGINEERING

A. POWERPLANT INSTALLATION

Several propulsion system - airframe installations were statically tested during this reporting period to determine the effects of aerodynamic loading.

The airframe-furnished main fan inlet closure door was tested statically with a lift fan to evaluate door and lift fan deflections under the maximum aerodynamic loading conditions. The closure doors were loaded using shot bags, with the lift fan mounted on its side in a special mounting fixture. Strain gage and deflection measurements were taken at critical points on the lift fan. Both the closure door and lift fan met design expectations. A dye-penetrant inspection was made of the lift fan rotor hub area after the test and no crack indications were revealed. A report on the static test is being prepared by the airframe manufacturer.

The exit louver push rod system was also tested with the exit louver actuators to maximum load conditions. No yielding or distortion was noticed, although during one condition, with the louvers almost fully closed the push rod slipped laterally off the side of the cam stop. To prevent recurrance of this condition, push rod guides have been added inside the rear frame strut at the aft end to prevent any possible lateral movement of the push rod.

B. PITCH FAN REVERSE PERFORMANCE

Development tests were completed during the reporting period on several methods of improving the reverse thrust capability of the pitch fan thrust modulating system. These tests were performed on full scale test hardware in the Evendale fan test facility and consisted of the following configurations:

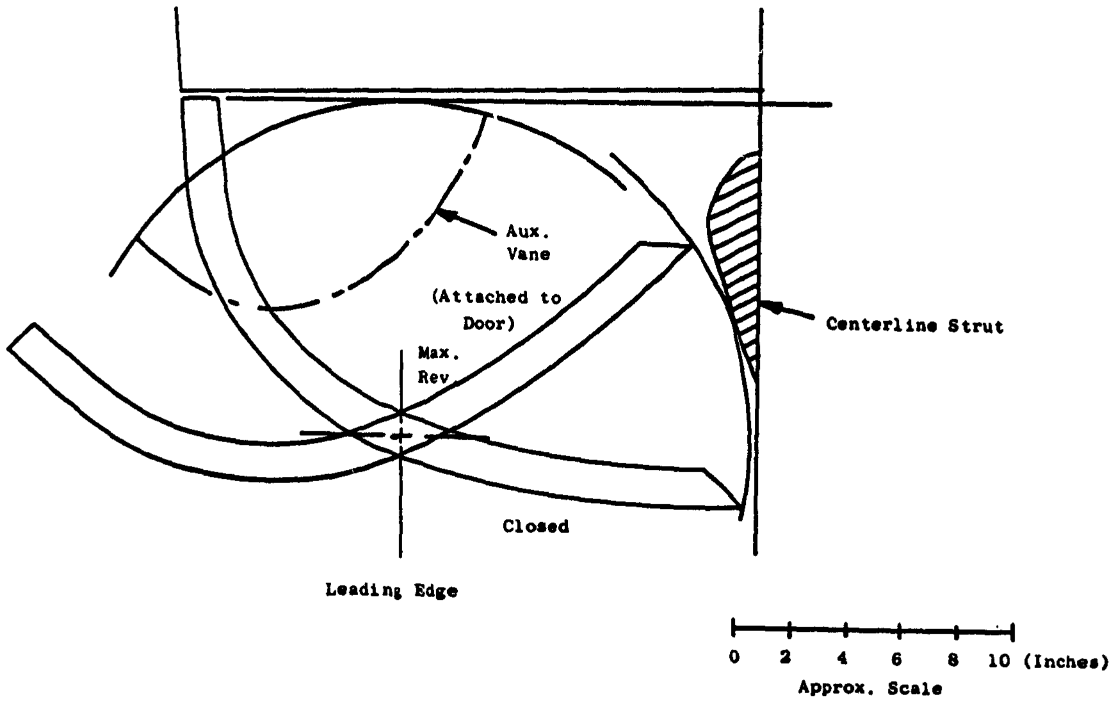

Figure 1. Sketch of System for Increasing Reverse Thrust Capability of Pitch Fan

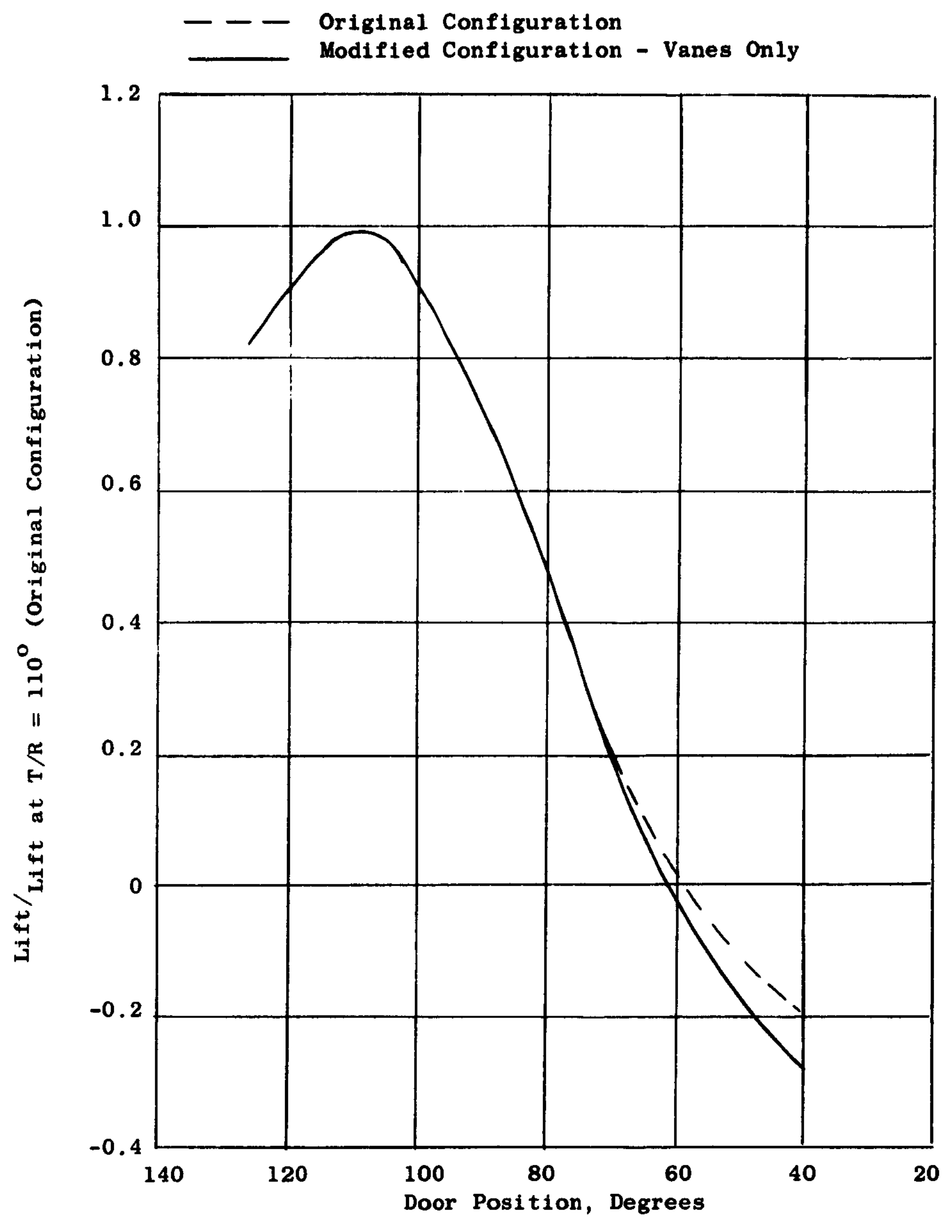

Figure 2. Comparison of Lift Variation - Pitch Fan (Original Versus Add-On Vanes)

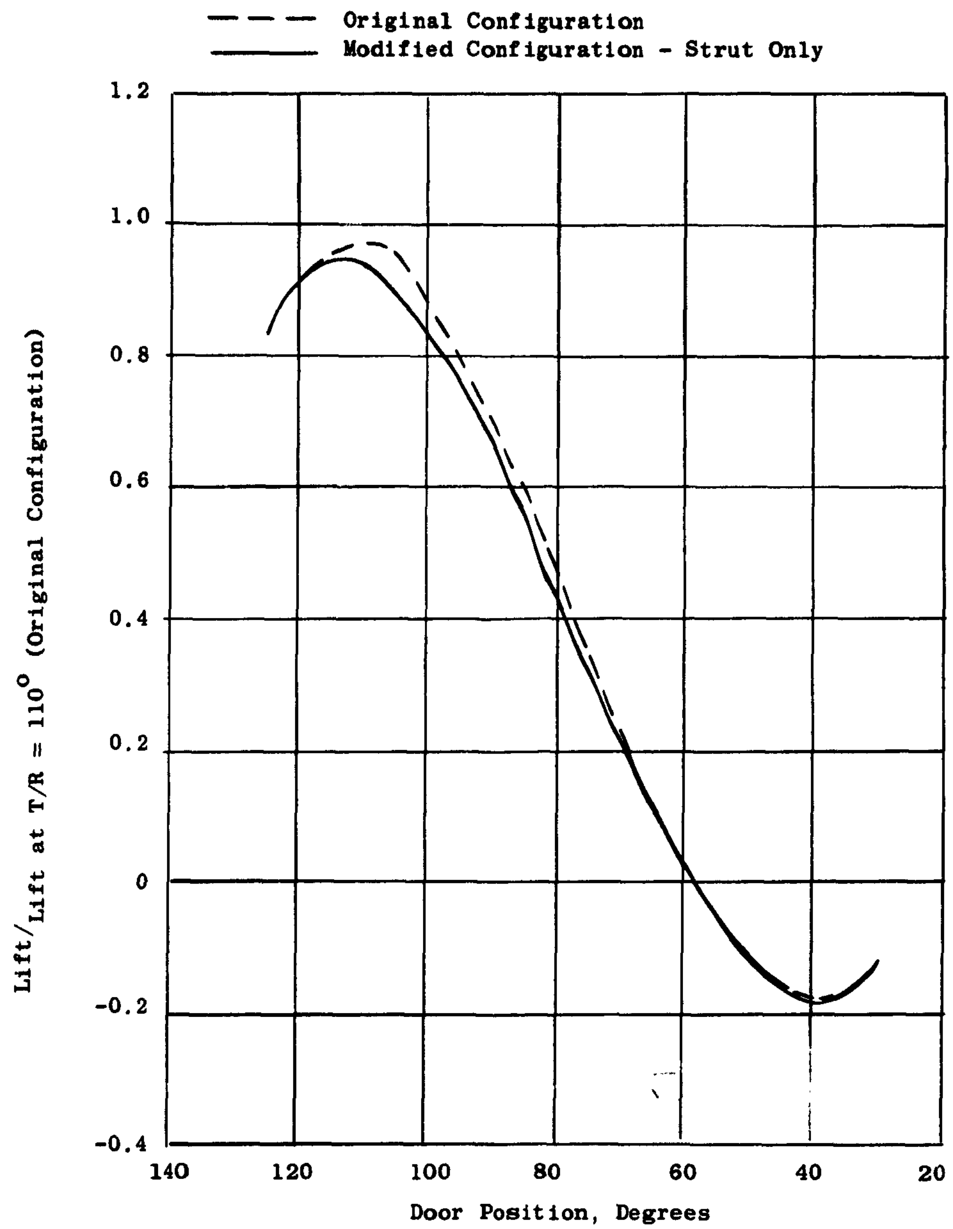

Figure 3. Comparison of Lift Variation - Pitch Fan (Original Versus Auxiliary Strut)

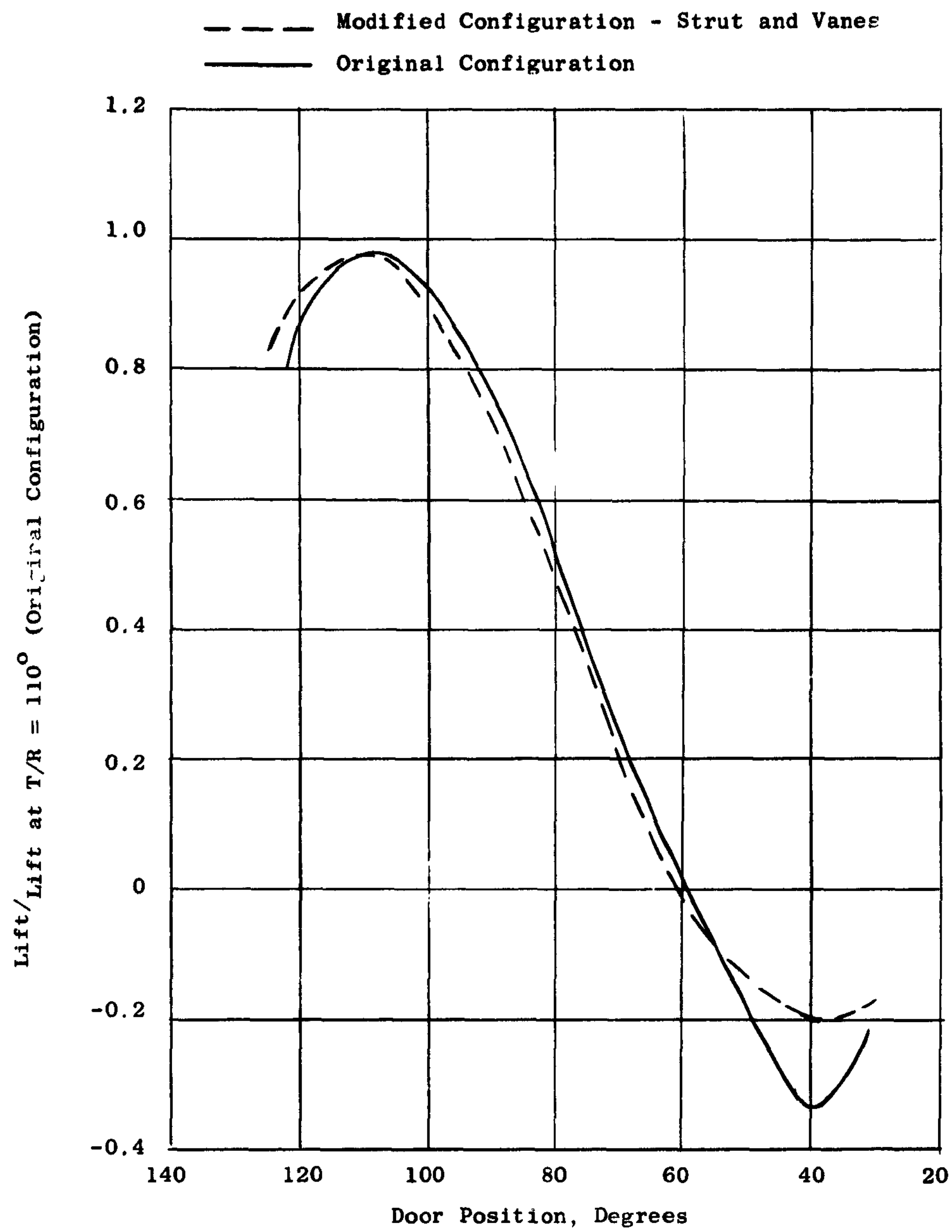

Figure 4. Comparison of Lift Variation - Pitch Fan (Original Versus Combination of Strut and Vanes)

C. SPECIFICATIONS AND REPORTS

A revised Plan For Performance, Report Number 111A, was written and submitted to TRECOM for approval. Government approval for this new plan and schedule was received at the end of the reporting period.

The Detailed Flight Test Plan Report Number 129, was completed, submitted for TRECOM approval, and discussed in detail with U.S. Army technical personnel. An understanding was reached which should lead to Government approval early in the next reporting period.

Seven technical reports, describing detail ground test procedures, plus stress and structural analysis, were completed and transmitted to TRECOM for information and reference purposes. The aircraft structural reports will be summarized and referenced in the final aircraft design analysis report ("Final Flightworthiness Summary and Reliability Report" to be submitted at the program conclusion.)

D. AIRPLANE SUPPORT

1. Ejection Seat - North American LW-2

Final drawings, reports, and development test summaries of the LW-2 ejection seat system were completed during the reporting period and forwarded to the Contracting Agency.

Two additional test firings of the LW-2 seat were made during this period which were not a part of the XV-5A test and development program. Both firings were "through the canopy" type at ground height and zero forward velocity.

The first test was performed in a side by side simulated cockpit which contained a stick, throttles, instrument panel, windshield

D. 1. and canopy. This particular cockpit configuration permitted less clearance, both side and aft than the XV-5A cockpit. A dummy pilot was installed in the right side of the cockpit with instrumentation to record surface temperatures. The underside of the canopy was coated with lipstick which proved a very effective means of determining areas of canopy contact by the ejection seat and dummy.

The seat firing was successful up to the point of personnel chute deployment. The drogue slug line parted at the harness release attach point and did not deploy the personnel chute. Canopy contact was made by the dummy's helmet, left shoulder and both knees. The dummy's shoes contacted and broke the bottom member of the instrument panel. The right hand simulated pilot showed no signs of high temperature impingement from the rocket blast of the left hand seat firing. As a result of this test, North American has recommended that certain modifications be made to the LW-2 ejection seat prior to its use with the canopy used in the test firing. The recommended modifications are to replace the adel pin at the harness release attach point with a bolt and to shorten the harness release handle. Both modifications can be made on the three LW-2 seats presently available for the XV-5A and request to perform these modifications will be made to TRECOM.

The second LW-2 seat firing was made through a tandem seating cockpit having a canopy of stretched acrylic plastic heavier than the XV-5A. The firing did not utilize the rocket. All components of the seat performed satisfactorily.

The LW-2 seat is presently planned to be used during the initial 50 hour flight test of the XV-5A.

D. 2. Ejection Seat - Douglas

During the reporting period, three un-modified Douglas A4D seats were furnished by TRECOM for use as alternate or backup escape systems on the XV-5A. All necessary modifications to the two airplanes were completed to permit installation of the Douglas seats or the LW-2 seats as desired. Still unresolved at the time is the "through-the-canopy" capability of the A4D seat and the required method of airplane egress for airspeeds under 80 knots. No test demonstration program is planned for the Douglas seats.

III. MANUFACTURING AND FLIGHTWORTHINESS TEST

A. FULL SCALE MANUFACTURE

1. Main Lift Fan

All required hardware for the six program lift fans has been completed. The remaining circular inlet vane assemblies, rotor bucket carriers, and rework modifications to the exit louvers described in the previous progress report were completed during this reporting period and installed on the fan assemblies.

2. Assembly and Acceptance Testing

Acceptance testing was completed on two main fans and one pitch fan during the reporting period. These last three fans, which are program spares, brings to a close the initial manufacturing assembly, and acceptance testing of propulsion system hardware. Maintenance support for the propulsion systems will be supplied throughout the remaining aircraft ground and flight tests.

Fan status by serial number is as follows:

Lift Fan

003L FWT vehicle, re-assembled, installed in test facility, completed acceptance test.

004R Accepted by Army, shipped to Ryan, fitted and installed in aircraft #2. Inlet vanes and exit louvers have been installed.

005L Accepted by Army, shipped to Ryan, fitted and installed in aircraft #1. Inlet vanes and exit louvers have been installed.

A. 2. 006R Accepted by Army, shipped to Ryan, fitted and installed in aircraft #1. Inlet vanes and exit louvers have been installed.

007L Accepted by Army, shipped to Ryan, fitted and installed in aircraft #2. Inlet vanes and exit louvers have been installed.

008R Accepted by Army, at General Electric, available as program spare.

Pitch Fans

001 FWT vehicle, accepted by Army, at General Electric, available as program spare.

002 Accepted by Army, shipped to Ryan, fitted and installed in aircraft #1.

003 Accepted by Army, shipped to Ryan, fitted and installed in aircraft #2.

B. GOVERNMENT FURNISHED EQUIPMENT

1. YJ85 Engines

Engines S/N 230-161 and -167 are installed in the test facility for use in fan testing. There has been no change in the status of the other YJ engines. Table I presents the YJ85 running record.

2. J85 Engines

Engine S/N 230-875 and 876 have been processed through the General Electric Service Shop at Strothers Field, Kansas for modification to the J85-5B configuration and installation of firewalls. These engines were delivered to Ryan in September and along with engine S/N 230-729 and -730 have been installed in the two XV-5A aircraft.

TABLE I YJ85 RUNNING RECORD

		AF Time			
Engine S/N	Location	Prior (Hrs.)	Since P.I.[a] (Hrs.)	Evendale (Hrs.)	Status
203-105	Evendale	87:20	11:23	0	Serviceable
-113	Evendale	62:05	1:17	0	Missing some accessories; can be made serviceable.
-114	Evendale	153:10	1:54	1:00	Over limit vibration, requires rebalance.
-121	Evendale	89:05	4:06	8:00	Transferred to Navy.
-129	Evendale	26:30	1:12	0	Serviceable, but has vibration history, expect to have only limited use.
-134	Evendale	152:30	1:06	29:00	Over limit vibrations, requires re-balance used during FWT assurance tests with marginal vibs but was unacceptable after re-installation for acceptance testing.
-136	Evendale	50:15	9:51	0	Missing some accessories; can be made serviceable.
-161	Evendale	111:25	0	100:51	Used in FWT assurance test; continuing in use in acceptance testing.
-163	Evendale	69:45	1:21	0	Serviceable.
-167	Evendale	154:50	1:44	57:46	Installed for acceptance testing.

a. Includes test cell time

B. 2. Four new J85-5A engines have been received. It is planned to install the heat shield and firewall on one engine, which will then be readily available for rapid replacement in either aircraft. The remaining three engines will be prepared such that heat shield and firewall installation can easily be made as required. The J85 running record is presented in Table II.

C. FLIGHTWORTHINESS TEST

The Flightworthiness Penalty Test Report was completed during the reporting period and transmitted to TRECOM.

D. MAINTENANCE MANUAL

Revisions to the Propulsion System Maintenance Manual are 90% complete and will include inputs from the installation effort at Ryan.

TABLE II J85 RUNNING RECORD

Engine S/N	Location	Prior (Hrs.)	Since P.I. (Hrs.)	Strother's (Hrs.)	Status
230-729	Ryan	79:16*	1:49	1:49	Modified to -5B configuration, heat shield and firewall installed at Strothers. Shipped to Ryan and installed on aircraft.
-730	Ryan	80:40*	2:44	2:44	Modified to -5B configuration, heat shield and firewall installed at Strothers. Shipped to Ryan and installed in aircraft.
-875	Ryan	--	1:04	1:04	Modified to -5B configuration, heat shield and firewall installed at Strothers. Shipped to Ryan and installed in aircraft.
-876	Ryan	--	1:01	1:01	Modified to -5B configuration, heat shield and firewall installed at Strothers. Shipped to Ryan and installed in aircraft.
231-230	Evendale	0	0	0	-5A configuration - new
-231	Evendale	0	0	0	-5A configuration - new
-232	Evendale	0	0	0	-5A configuration - new
-233	Evendale	0	0	0	-5A configuration -new

* Running time from flightworthiness test

IV. AIRCRAFT GROUND TEST SUPPORT

A. AIRCRAFT RESONANCE TESTS

Tests to determine the resonance characteristics of the airframe were conducted during this period with the powerplants installed so that data could be obtained on:

1) The response of the fan rotors, as a result of wing and/or fuselage excitation.

2) Possible excitation of the airframe due to particular rotor vibratory modes.

Since a large portion of a typical operational mission would be conducted with the lift and pitch fans at essentially zero rpm, these powerplants could be subjected to vibratory excitation during flight through rough air and over long periods of time. Some dovetail and bearing wear might be encountered since the seating effect of centrifugal force on the dovetail or the load distributing effect of bearing rotation is not present at zero rpm. To obtain quantitative data on these effects it was desired to have the fans installed during aircraft resonance testing but at the same time not subjected to the long-time vibration inherent during the test. This was accomplished by blocking the rotor during most of the testing to prevent blade movement relative to the disc.

A relatively short test period was devoted to resonance testing with unblocked rotor to determine if free rotor vibratory modes would influence the airframe wing or fuselage modes. The free rotor testing showed that the fans had no measurable influence on the model pattern or natural frequencies of the airframe and that the fan rotor could be considered a concentrated "mass" having no effect on aircraft vibration, other than its own mass and inertia.

A. Since no rotor teardown and inspection was scheduled subsequent to the resonance test, an .80 "g" limit was initially specified for the fan accelerometers to prevent lifting of the rotor with the associated dovetail wear and bearing Brinelling. As the test progressed, however, it became apparent that several fundamental fuselage modes could not be developed within these fan rotor limits. As a result, each rotor blade was tied to the exit rotors with bungee and pre-loaded downward to allow at least 1.3 "g" acceleration with no blade movement. With this fix the testing was completed satisfactorily.

With accelerometers on the blades (hub and tip of one blade and the tip of a blade 90° away) it was determined that the rotors were responding at the same frequency as the exciting force, whether blocked or unblocked. With an unblocked rotor it was also found that the blade tip and hub were in place, i.e., there was essentially no bending at the blade root. This favorable characteristic would tend to minimize dovetail wear.

The J85 engines were instrumented with identical accelerometers (forward compressor vertical, aft compressor horizontal and turbine horizontal) with similar "g" limits. In addition, both engines were rotated every five minutes during the test to prevent local bearing wear.

Data from the fan and engine accelerometers, together with the wing tip mounted "master" accelerometer were recorded on magnetic tape and is currently being analyzed in detail at Evendale.

B. FULL SCALE WIND TUNNEL TEST

Considerable progress has been made in preparation for the full scale wind tunnel test of the XV-5A aircraft in the 40 x 80 foot wind tunnel facilities at NASA-Ames Research Center. Summarized below is the progress achieved during the reporting period in each planning area.

1. Detailed Test Plan

The detailed test plan for the full scale tests was completed and submitted to NASA-Ames for review. The comments that were received were included where applicable into the final test plan, due for issue during the next reporting period. Included in the test plan will be a general description of the systems to be tested as well as test run schedules and instrumentation requirements.

2. Aircraft Mounting System

The design of the mounting system to be used during the tests has been completed with the hardware released for manufacture. A three-point mounting system will be used with two fittings on the wing leading edge and the third on the fuselage just forward of the engine exhaust nozzles. Existing jack pad fittings provided with the aircraft will be used for the wing mount system and a special adapter will be provided for the tail mount. Mounting loads were evaluated as to the operational limits to be established for use during the wind tunnel tests. Figure 5 shows the estimated test limits at high power settings.

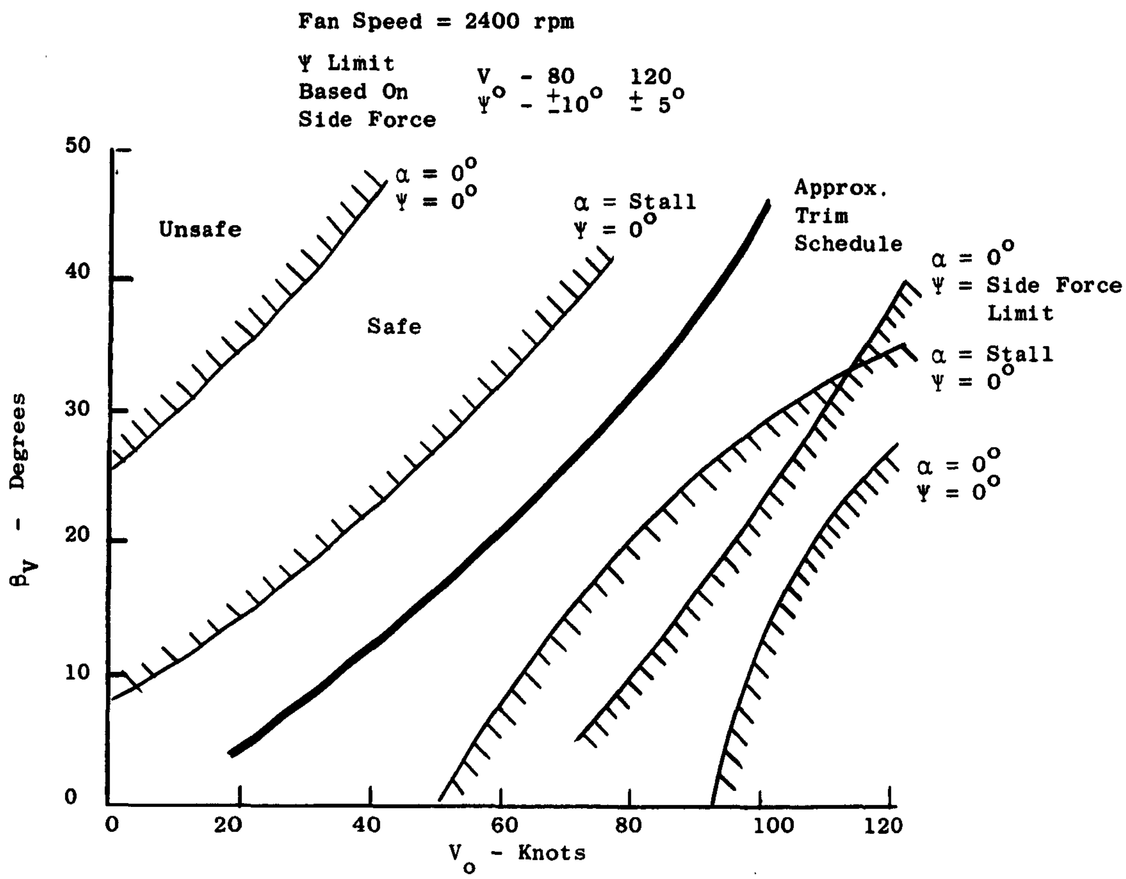

Figure 5. Estimated Operational Limits For XV-5A Wind Tunnel Tests

B. 3. Remote Actuation and Instrumentation

During this reporting period, design was completed on a system to provide remote actuation for all pilot operated aircraft controls. This system will mount in the cockpit area and provide actuation for the throttles, conventional stick, rudder pedals, and collective stick by use of pneumatic and electrical actuators. Appropriate switching and position indicating will be provided to the remote operator's console. Specific cockpit instruments and switches will also be provided on the console. Initial setup had begun at the end of the reporting period.

4. Research Instrumentation

A high speed digital recording system will be used to record the aircraft instrumentation with the exception of the propulsion system vibration and stress data. The specification for the instrumentation requirements and measurements was completed during this period, and all special equipment for this system has been designed and is in manufacture.

5. Aircraft Utilities

Systems to supply full and electrical power have been designed and were in manufacture at the end of this reporting period.

6. Data Reduction and Analysis

Plans are in process to provide rapid automatic processing of the wind tunnel data. The computing facilities at NASA-Ames along with some local equipment will be used. At the close of this period the program for the data reduction and evaluation is being written for two to three day data processing. This should allow for timely inclusion of the data into the flight test program.

B. During the next reporting period, all preparatory plans for the wind tunnel test program will be completed and the aircraft readied for the wind tunnel installation.

V. FLIGHT TEST SUPPORT

A. INSTRUMENTATION

The installation and checkout of the required propulsion system instrumentation was completed during the reporting period.

Modifications to the PCM airborne data acquisition system were completed during the period; and the system was functionally tested and accepted. The modifications consisted of increased temperature readings, temperature compensation, and a tape remaining indicator. Installation of the PCM system into the aircraft will take place early in the next reporting period.

The tape transport (recorder) from the PCM system was used during the aircraft ground resonance testing to record propulsion system data, and it operated satisfactorily.

B. FLIGHT TEST PLAN

Report number 129, Detail Flight Test Program was completed and submitted to the Contracting Agency during this period. The program details generally follow the Basic Flight Test Program Report Number 121, issued earlier, and calls for approximately 27 hours of V/STOL flight and 23 hours of conventional flight in the 50 hour total program. Initial "wheels-off" flight will be made at hover or very low forward velocity fan-powered mode, followed by conventional flight evaluation.

Arrangements have been completed for use of most of the required government facilities. Still in question is the availability of the Air Force VTOL Thrust Stand at Edwards Air Force Base. Close contact

B. with the responsible Air Force unit has been maintained, both to keep abreast of the stand construction status and to integrate the XV-5A instrumentation and installation requirements for use on the test stand. No firm schedule of this thrust stand is available at the end of the reporting period.

VI. MILESTONES

Number	Milestone	Planned Date	Actual Date	Anticipated Date
21A	Government Acceptance of pitch fan (PF001)	Nov. 15	Nov. 13	

NOTE: Milestones are in accordance with the revised Plan For Performance, Report Number 111A, dated October, 1963.

SECTION B. AIRCRAFT

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Cont'd.)

TABLES

I. SUMMARY

This is the eighth of a series of quarterly progress reports to be submitted by Ryan Aeronautical Company under contract DA44-177-TC-715.

During the eighth quarter (August 20, 1963 to November 15, 1963) progress included:

- The 1/6 Scale Powered Model Wind Tunnel Report, Ryan Report 63B092 completed and issued.

- Updated trimmed transition calculations based on latest engine installed performance data and minimum stagger at conversion speed mixer box change.

- High Speed Conventional Flight Wind Tunnel Report, Ryan Report 63B087 completed and issued.

- Analog computer connected to the hydraulics and controls simulator for commencing the final hovering and transition simulation.

- Stress Analysis Group completed and issued the Empennage Stress Analysis Report, Ryan Report 63B100; Weighing Miscellaneous Stress Report, Ryan Report 63B118; Weighing Basic Structure Report, Ryan Report 63B096.

- Evaluation and writing of the static proof test results initiated, which was 20 percent complete.

- All Loads Group efforts complete. A final digital program for evaluating aeroelastic characteristics of the empennage assembly complete.

- No. 2 aircraft weighed at its flight test configuration. Actual weight certified by Ryan Quality Control at 7541 pounds.

- Preliminary control surface-tab flutter analysis complete.

- Ground resonance tests complete.

- Horizontal-stabilizer actuator has not met all specification requirements; second source units to be available for the flight test program.

- At the end of the reporting period:

  Ship No. 1 was 92 percent complete.

  Ship No. 2 was 94 percent complete.

- Installed Systems Functional Test Procedure, Ryan Report 63B102, completed and issued.
- Ground test instrumentation design complete with 90 percent installed in both aircraft.
- Signal conditioner box and photo panel completed and trial fitted into aircraft.
- Hydraulics and controls simulator complete and checked out with approximately 30 hours of running time.
- Detail Flight Test Plan, Ryan Report 63B001, completed and submitted.

II. DESIGN AND ENGINEERING

A. STABILITY AND CONTROL

1. Progress

The 1/6 Scale Powered Model Wind Tunnel Report, Ryan Report No. 63B092, was completed and issued. The Static Stability Report was 75 percent complete, and the Dynamic Stability Report was 30 percent complete at the end of this period.

The Stability and Control Group conducted further refinements of data in support of the pending Flight Test Program. Updated trimmed transition calculations are presented in Figure 1, which presents the latest estimates of transition performance. This data includes latest power available data using the General Electric Customer Performance deck with final gas generator power extraction information, as well as the data from the revised mechanical mixer box scheduling of minimum stagger versus vector angle. At conversion speed, minimum stagger has been reduced from 13 degrees to 6 degrees resulting in an increase in forward thrust at conversion speed.

Additional studies of the thrust spoiler were conducted during this period utilizing wind tunnel data from the Ames 40 foot x 80 foot wind tunnel. The estimated curve of thrust spoiler effectiveness is presented in Figure 2 and should be viewed with caution. The wind tunnel data showed fair agreement with previous effectiveness estimates, but also pointed out some unfavorable pitching moment. Differences between the Ames model and the aircraft thrust spoiler geometry bar any conclusion at this time. The full scale aircraft thrust spoiler will be tested during Ames full scale wind tunnel tests prior to flight use to verify thrust spoiler performance.

At the end of this period, the Stability and Control Group started checking the Simulation Program to determine accuracy of airplane presentation. Static trim calculations are being used to check the Analog Program.

2. Schedule

The Dynamic Stability Report was behind schedule, however this will be completed in sufficient time to support the Flight Test Program. All other elements were on schedule.

3. Plans for Continuing

a. Completion of Static and Dynamic Stability Reports.

b. Completion of 6 degree-of-freedom hovering and transition simulation utilizing a complete hydraulic and control system.

c. Completion of 6 degree-of-freedom conventional flight simulation.

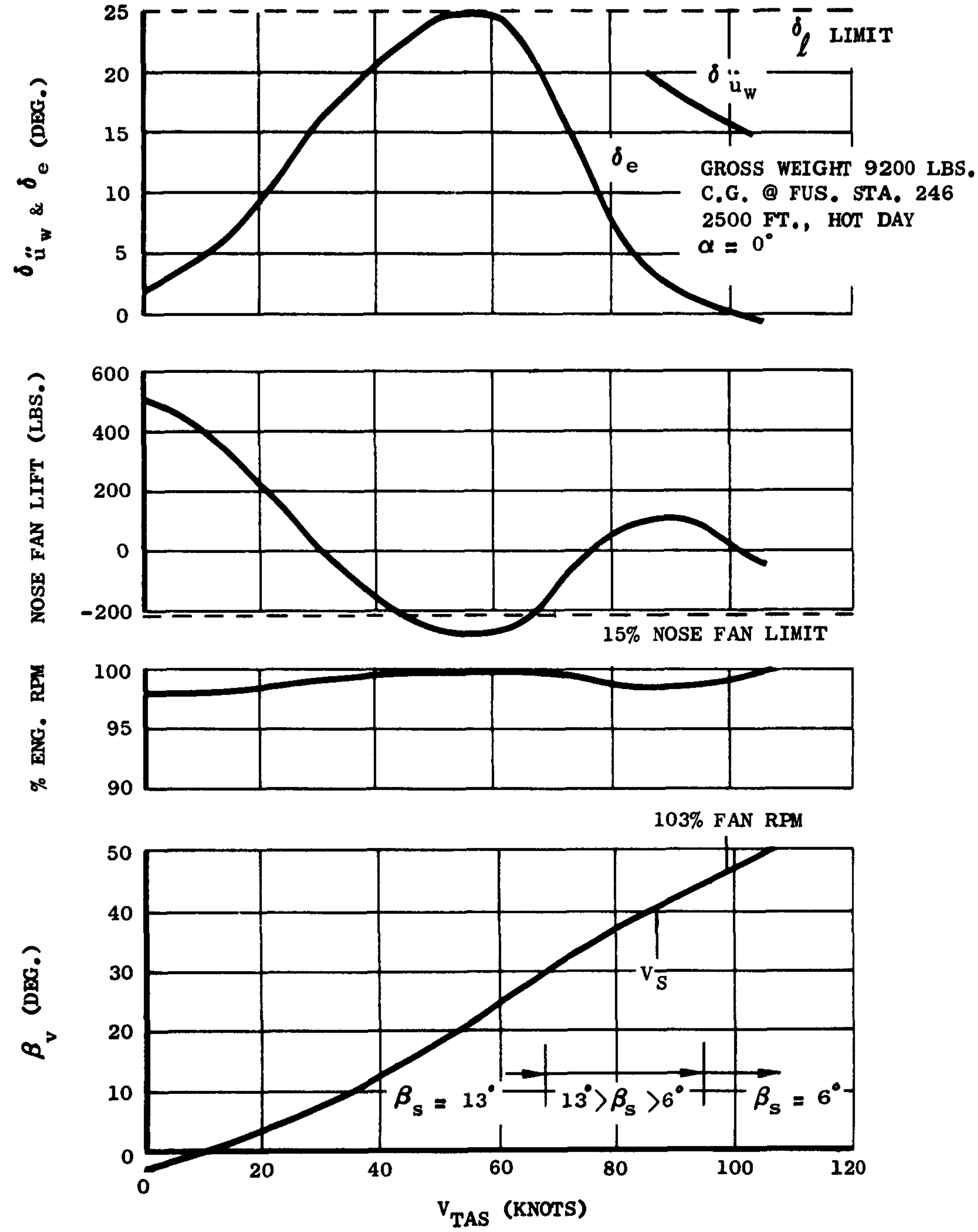

Figure 1 XV-5A Trimmed Transition Performance

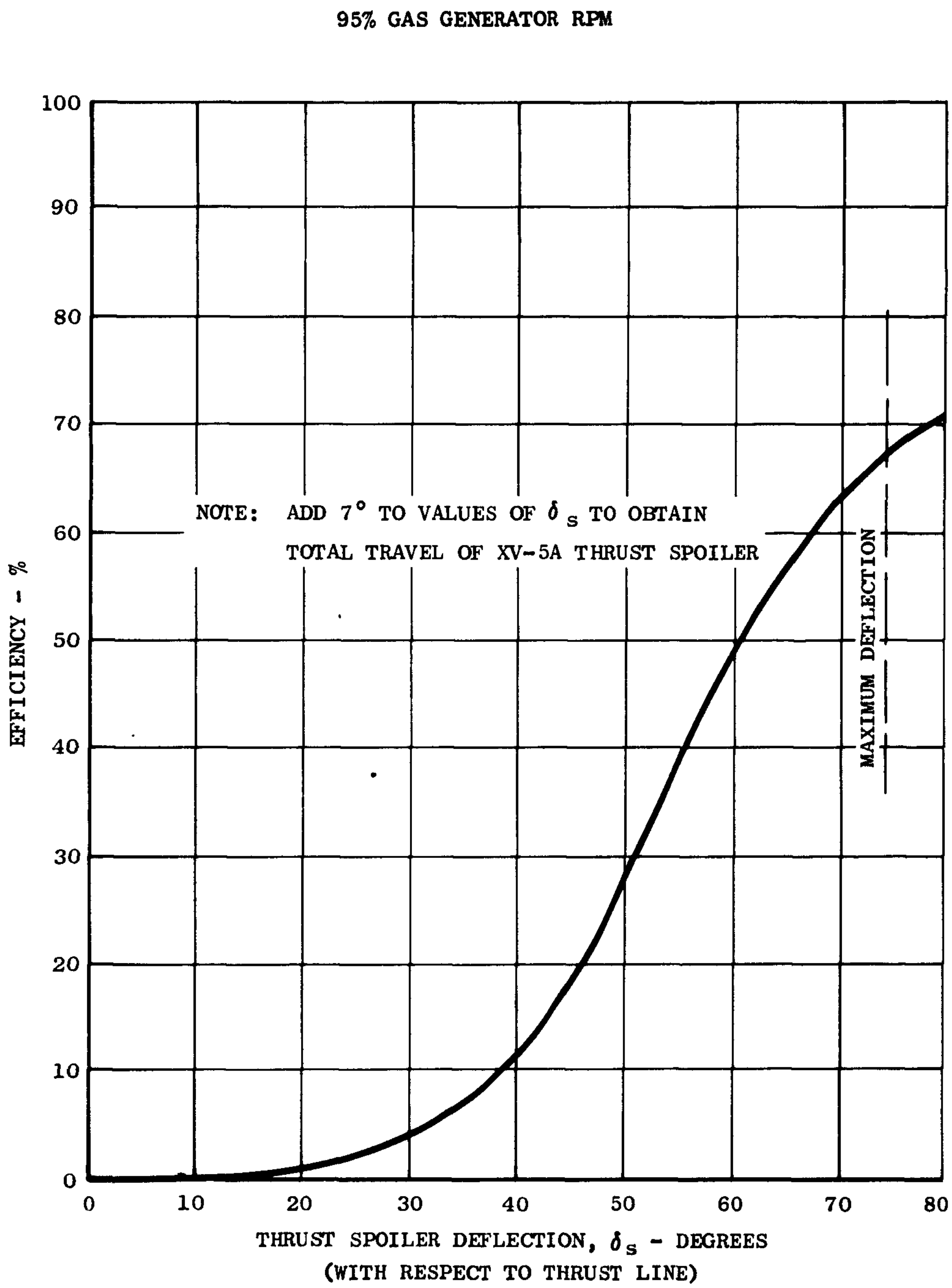

Figure 2 Estimated Thrust Spoiler Efficiency vs Thrust Spoiler Deflection

B. AIRPLANE PERFORMANCE

1. Progress

The Performance Group continued updating in preparation for flight test. The High Speed Conventional Flight Wind Tunnel Report, Ryan Report 63B087, was issued. The Low Speed Conventional Flight Wind Tunnel Report was completed and further amended during this period and will be issued early in December 1963.

The Final Performance Report was 85 percent complete and will be issued in mid-December.

2. Schedule

The Performance Group was on schedule with the exception of the Low Speed Conventional Flight Wind Tunnel Report.

3. Plans for Continuing

After completing the performance reports, the Performance Group will devote all efforts in supporting the Flight Test Program.

C. CONTROL SYSTEM ANALYSIS AND SIMULATION

1. Progress

The systems analysis effort was concentrated in three main areas during this reporting period:

Control system hardware evaluation.

Computer simulation modification to achieve compatibility with the hydraulic and controls simulator.

Stability augmentation root locus analysis incorporating results of the actual hardware evaluation.

Hardware evaluations were conducted on the airplane during ground resonance testing and on the hydraulic and controls simulator. A few conditions were identified which required correction.

The rate gyro mount natural frequency was measured at about 17 cycles per second in roll, which corresponds to the frequency of an asymmetric wing mode. This condition resulted in considerable 17 cycles per second noise in the fan exit louver servo actuator stability augmentation input. The rate gyro mounting was redesigned and replaced. This mounting offers a high natural frequency, thus eliminating the artificial noise induced at the louver actuators.

Test of the nose fan thrust reverser doors indicated that longitudinal structural feedback instability occurred at the expected flight stability augmentation pitch gain. The pitch fan doors oscillated at 13 cycles per second. An 11 cycles per second notch network was installed in the pitch stability augmentation channel and effectively eliminated the feedback problem. However, it was subsequently decided that a 15 cycles per second notch network would be incorporated in all three channels so that they would remain interchangeable, and also eliminate the possibility of 17 cycles per second noise in the roll channel. Root locus analysis indicated that the 11 cycles per second notch network had excessive effects on the airplane stability augmentation short period characteristics. During the next month, while the airplanes are in installed systems functional test, the stability augmentation system will be tested again to verify the choice of the 15 cycles per second notch network.

Hydraulic simulator tests on the nose fan door system, using simulated door masses, showed that the doors exhibited the characteristics of a spring-mass system, resonant at 9 cycles per second with a small damping ratio. The effect of this added response has been included in the latest root-locus analysis, and has little overall effect on the short-period characteristics.

The frequency response of the nose fan door system was conducted and the data analyzed. No adverse condition was identified.

The first actual tests of the roll-yaw bridge concept, using actual louver actuators, were completed, and the system performed and met specification requirements. A single valve coil failure test was also conducted and resulted in negligible cross-coupling from roll to yaw.

Root locus plots were made utilizing the latest servo hardware data and the 15 cycles per second notch network. Plots were made so that the airplane short-period hovering characteristics can be determined for any combination of stability augmentation ratio and gain settings.

The Analog Computer was connected to the Hydraulic and Controls Simulator on 17 November 1963. After a brief period of checkout and verification, the simulator will be utilized for final pilot evaluation of the XV-5A hovering and transition flying qualities.

2. Schedule

The systems analysis effort was behind schedule due to the late completion of the Hydraulic and Controls Simulator.

3. Plans for Continuing

a. A further ground test will be performed to test the stability augmentation system regarding the roll and pitch feedback problems to determine if the 15 cycles per second notch network is satisfactory.

b. The final hovering, transition and conversion simulation will be completed.

c. The Final Systems Analysis and Simulation Report will be initiated.

D. STRUCTURAL ANALYSIS

1. Progress

(a) Stress Analysis

During this reporting period the Stress Analysis Group completed and issued the Empennage Stress Analysis Report, Ryan Report 63B100; Wing Miscellaneous Stress Report, which includes analysis of flaps, aileron, fitting, Ryan Report 63B118; and the Wing Basic Structure Report, Ryan Report 63B096.

The Control System Stress Report was 95 percent complete and the Fuselage Stress Report was 85 percent complete.

Introduction of final asymmetrical loads into the space frame computer program revealed that the two main side members had negative stability margins. The addition of braces, as shown in Figure 3, increased the column strength sufficiently to give positive margins of safety.

The evaluation of proof test results was started with the final report 20 percent complete. Wing deflections for the critical tests showed that twist was small as calculations had indicated. The vertical deflections of the spars however, were much smaller than calculated. This was due to the reduced modulus for temperature considered in the analysis, and actual spar cross sections which were greater than those used for the analysis.

The wind tunnel wing fitting mount was redesigned and re-analyzed to provide a higher margin of safety (3.0) for the maximum set of loads anticipated.

2. Schedule

The fuselage stress reports are behind schedule because of computer refinements, which allow complete analysis for all final loads.

3. Plans for Continuing

All stress reports will be completed in the next quarter. Any subsequent stress analysis efforts will be those required to support ground and flight tests, and support for any resulting design and liaison changes.

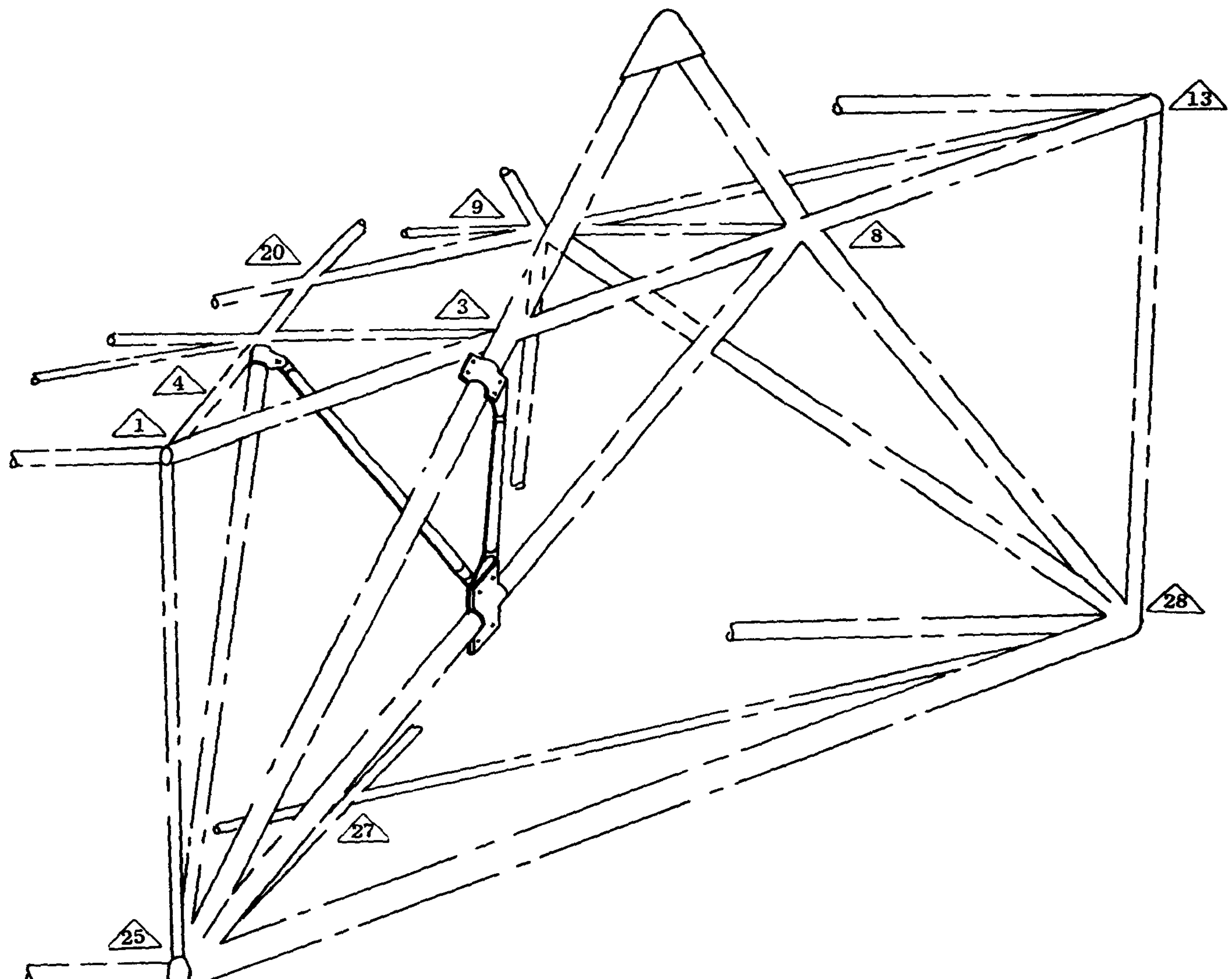

Figure 3 Braces Added to Stabilize Space Frame Members

(b) Loads Analysis

During this period, all loads analyses were completed. A digital program was completed for evaluating aeroelastic characteristics of the empennage assembly, and served to augment previous analysis.

Pertinent samples of the results from the aeroelastic analysis are presented in Figures 4, 5, and 6. Although the isolated empennage assembly was found to be relatively rigid, the illustrated results are due primarily to fuselage bending effects.

The final estimated loads report writing continued, and will be completed early next quarter.

2. Schedule

The Loads Group, being essentially completed, was on schedule.

3. Plans for Continuing

Plans for continuing next quarter include completing the final Calculated Loads Report and updating the Structural Design Criteria Report, Ryan Report 62B094.

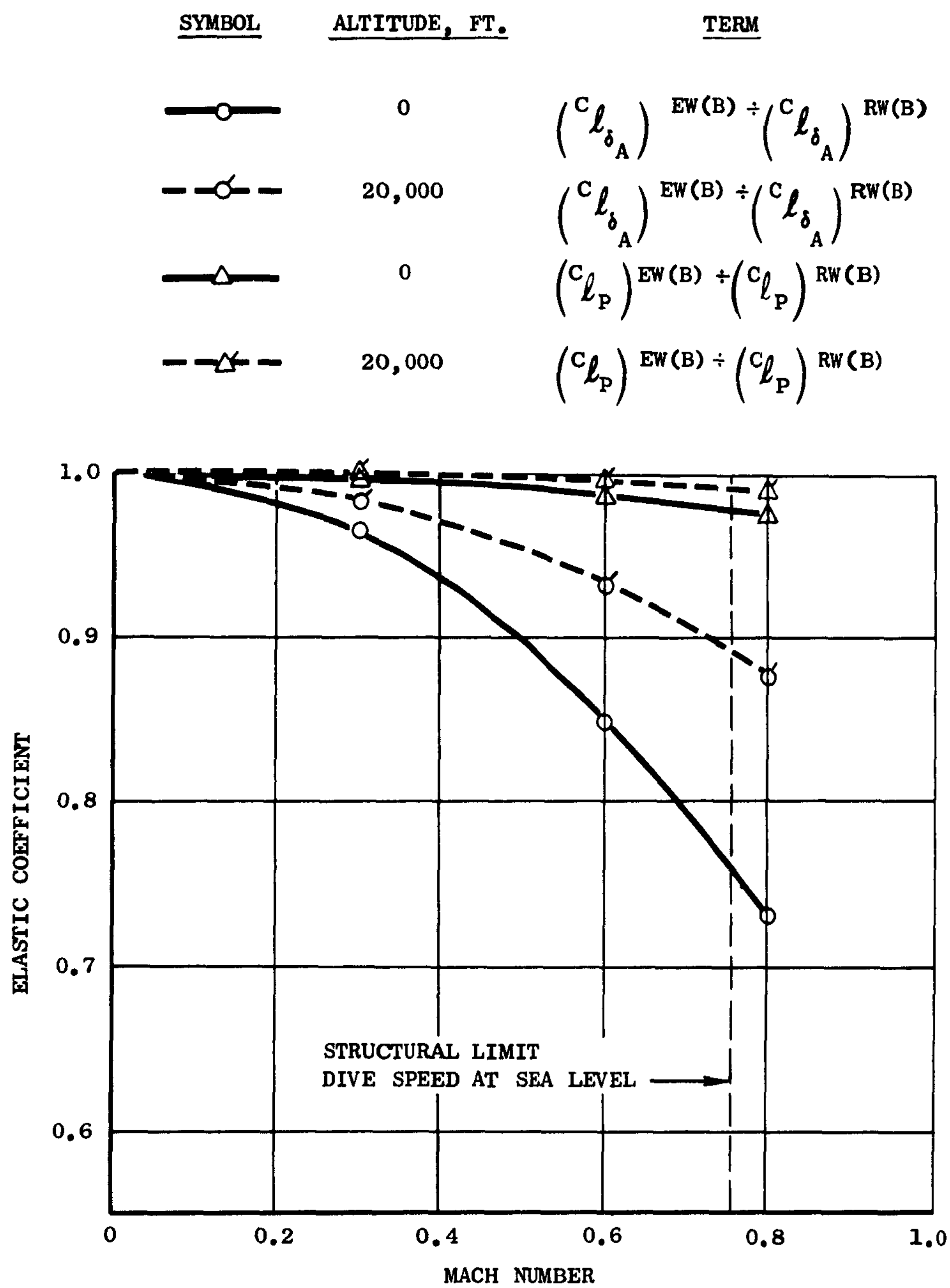

Figure 4 Aircraft Aeroelastic Characteristics - Wing Lateral Control and Roll Damping Derivatives

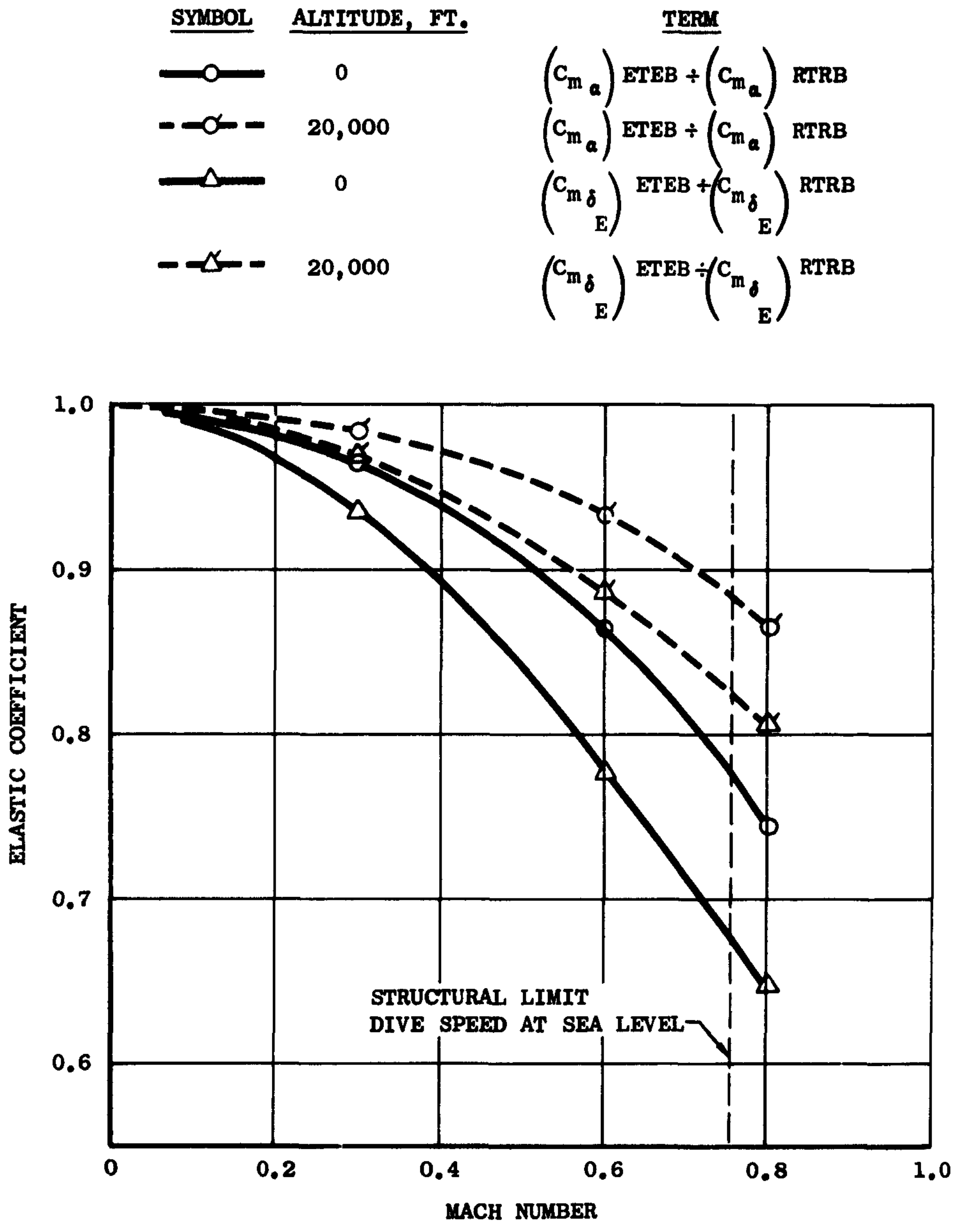

Figure 5 Aircraft Aeroelastic Characteristics - Tail Longitudinal Stability and Pitch Control Effectiveness Derivatives

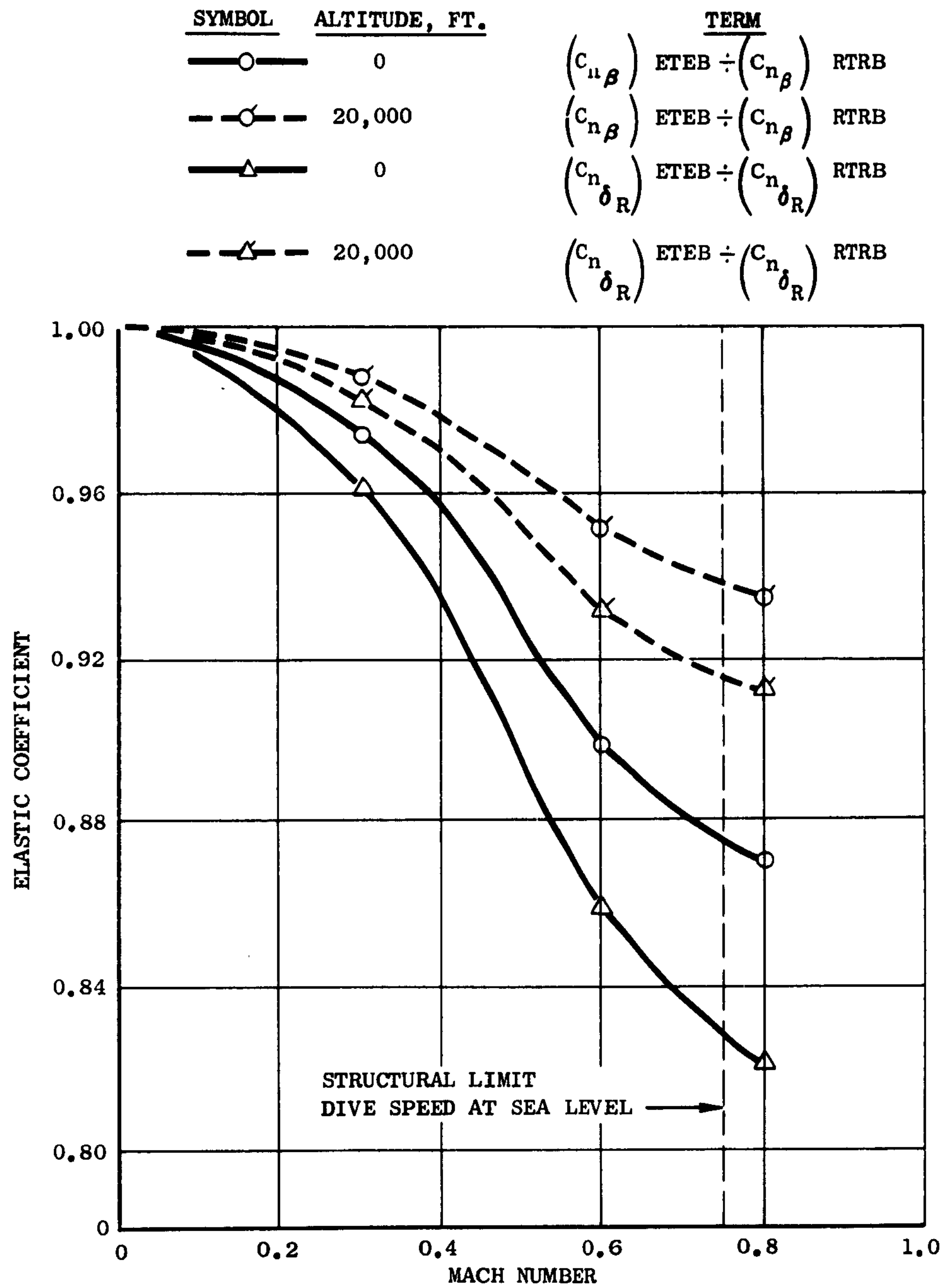

Figure 6 Aircraft Aeroelastic Characteristics, Tail Directional Stability and Yaw Control Effectiveness Derivatives

(c) Weight Control

During this reporting period, the Weight Control Group continued maintenance of the IBM Weight and Balance Program as a result of engineering changes and factory rework. Actual weights were recorded in the weight program, displacing estimated weights. At the close of this period, approximately 85 percent of the airplanes' weight empty parts had been recorded.

The final Calculated Weight Report was completed and will be issued early next period.

No. 2 ship, essentially being in its final flight test configuration, was weighed to determine its actual weight and center of gravity. This information was required in order to provide proper weight distribution for ground resonance testing. Fuel tanks were filled and pumped dry to determine unusable fuel weight. Comparison of the actual airplane weight with the current IBM Weight Program record showed only a 5 pound difference. The actual center of gravity was only 0.2 inch different. The actual weight empty was certified by Ryan's Quality Control Department at 7541 pounds. This is expected to increase slightly as tests show need for alterations.

As a result of the weight accounting procedure established for this airplane, a listing of the weight and number of parts by material and form is listed in Tables I and II.

2. Schedule

The weight control effort was on schedule at the end of this reporting period.

3. Plans for Continuing

The next quarter will include actual determination of fuel center of gravity travel. This will be accomplished by placing the airplane in several nose-up and nose-down positions on aircraft weighing scales with fuel added in measured increments. As each increment is added, the scale reactions will be read, permitting calculation of the center of gravity. Results of these calibrations will show a plot of fuel center of gravity versus quantity at various aircraft attitudes. Weight recording will continue to cover changes, and support the Flight Test Program.

TABLE I

COMPONENT WEIGHT DISTRIBUTION

Weight empty of the aircraft is comprised of the following:

Ryan Fabricated Parts	3289.99 lbs
General Electric Furnished Components (including ejection seat)	2792.28 lbs
Purchased Parts	1235.18 lbs
Standard Parts (AN, NAS & MS)	209.49 lbs

TABLE II

SUMMARY OF RYAN FABRICATED PARTS

	WEIGHT	*NO. OF PARTS
Aluminum	(1791.31)	(5320)
Sheet	960.11	3915
Extrusion	46.45	205
Chem-Milled	132.50	41
Honeycomb	32.75	14
Machined	544.07	534
Tubing		
Hydraulic	42.03	440
Other	33.40	171
Magnesium	(224.75)	(327)
Sheet	147.43	193
Machined	23.53	102
Chem-Milled	53.79	32
Steel	(508.73)	(1006)
Sheet	309.83	518
Machined	106.39	297
Tubing	83.38	166
Wire	2.27	20
Control Cable	6.86	5
Titanium	(295.34)	(648)
Sheet	240.22	559
Machined	16.27	78
Chem-Milled	38.85	11
Fiberglas	219.36	175
Plastic	1.83	21
Rubber	9.66	51
Corefill	1.35	1
Finish Paint	11.25	
MIN-K Insulation	35.99	38

TABLE II (Cont'd.)

	WEIGHT	*NO. OF PARTS
Teflon	1.71	16
Copper Wire	96.88	
Copper Bar	.11	2
Fabric	1.02	8
Hydraulic Fluid	31.62	
Brass	.88	9
Foam	3.39	6
Neoprene	.96	8
Tungsten	31.37	11
Superoilite	.74	6
Adhesive	11.62	
Total	3289.99	7653

*NOTE: The Word Part Means For One Particular Design. (There May Be Many Pieces Of One Part. Left And Right Hand Items Are Treated As Separate Parts.)

(d) **Flutter and Vibration**

(1) **Analysis**

Preliminary control surface-tab flutter analysis was completed. Surfaces analyzed included elevators, rudder-rudder tab and aileron-aileron tab systems. Analysis was restricted to rigid body motion of the coupled systems with a parametric study being conducted on the hydraulic or screw-jack restraints.

(2) **Experimental**

Ground resonance tests were completed. These tests included determination of the symmetric and anti-symmetric vibration modes of the complete airplane, control surfaces, and the resonances of other airplane components, including pitch fan doors, wing fan doors and thrust spoiler.

2. **Schedule**

The Noise and Vibration Report has been completed in rough form, and is currently undergoing clean-up prior to being published. Work on other reports has been delayed by the extensive manpower requirements of the ground vibration tests, which were conducted on an around-the-clock schedule. Section IV, Ground Test of this report, covers the ground resonance testing in more detail.

3. **Plans for Continuing**

During the next quarter, the results of the ground vibration tests will be reviewed and correlated with the preliminary flutter analyses. A concentrated effort will be directed toward completion of the Preliminary Flutter Analysis, Ground Vibration Test, and Flutter Model Test Reports. In addition, development will continue on a digital computer program to handle the final Wing Flutter Analysis, and to streamline existing computer method in the flutter area.

E. THERMODYNAMICS

1. Progress

Effort is continuing on three major fronts: heating and cooling, inlet performance, and final installed performance with major emphasis on the first and last items. The completion stage is rapidly approaching, with appropriate accounting of interrelationship effects in all three areas. The cooling system has been analyzed and balanced for sea level, ARDC standard day conditions for both turbojet and lift mode operation at military power conditions over the full range of flight speed.

Typical results are shown in Figures 7, 8, and 9. Estimated cooling air taken on board as a function of aircraft speed, assuming the fuselage section is pressurized to about 20 inches of water, is presented in Figure 7. Fuselage leakage will tend to increase these values somewhat. Note agreement of static performance in both lift and turbojet modes.

Figure 8 presents an estimate of air temperature entering the wing fan cavities in terms of fuselage pressure and aircraft speed and it is based on 0.8% diverter valve leakage. It is considered that the fan louvers could be partially opened during low speed conventional flight to augment fan cavity cooling if required.

Ejector performance was completed and is presented in Figure 9. It shows that the required flow rate (Table 5, pg. 91B, Quarterly Progress Report No. 2) is met at all aircraft speeds in the turbojet mode. The effect of ejector performance on installed turbojet mode powerplant performance is related through the secondary air pressure ratio.

Final installed performance analysis of the XV-5A powerplant system is approximately 90 percent complete. A convenient method of correlating fan static lift performance with gas generator operation has been developed, and is presented in Figures 10 and 11. Related through available gas horsepower, the data of Figures 10 and 11 represents the static performance prepared by General Electric for hot and standard days over an altitude range of 10,000 feet. The method permits assessment of power setting, gas generator performance, re-ingestion, ambient temperature, and altitude effects on static lift. Availability of similar fan performance versus available gas horsepower, under forward flight conditions, was obtained by correlations based on NASA-Ames full scale wind tunnel data referenced to static performance, to estimate forward velocity effects on aircraft performance.

2. Schedule

While still behind schedule, a strong overtime effort has closed the schedule gap to the point where an "on-schedule" status is expected by late December.

3. **Plans for Continuing**

Completions of the Heating and Cooling, Inlet Model Wind Tunnel and Final Installed Performance Reports are expected in late December. Support of Installed System Test Program and Flight Test Programs at Edwards Air Force Base and NASA-Ames will be provided.

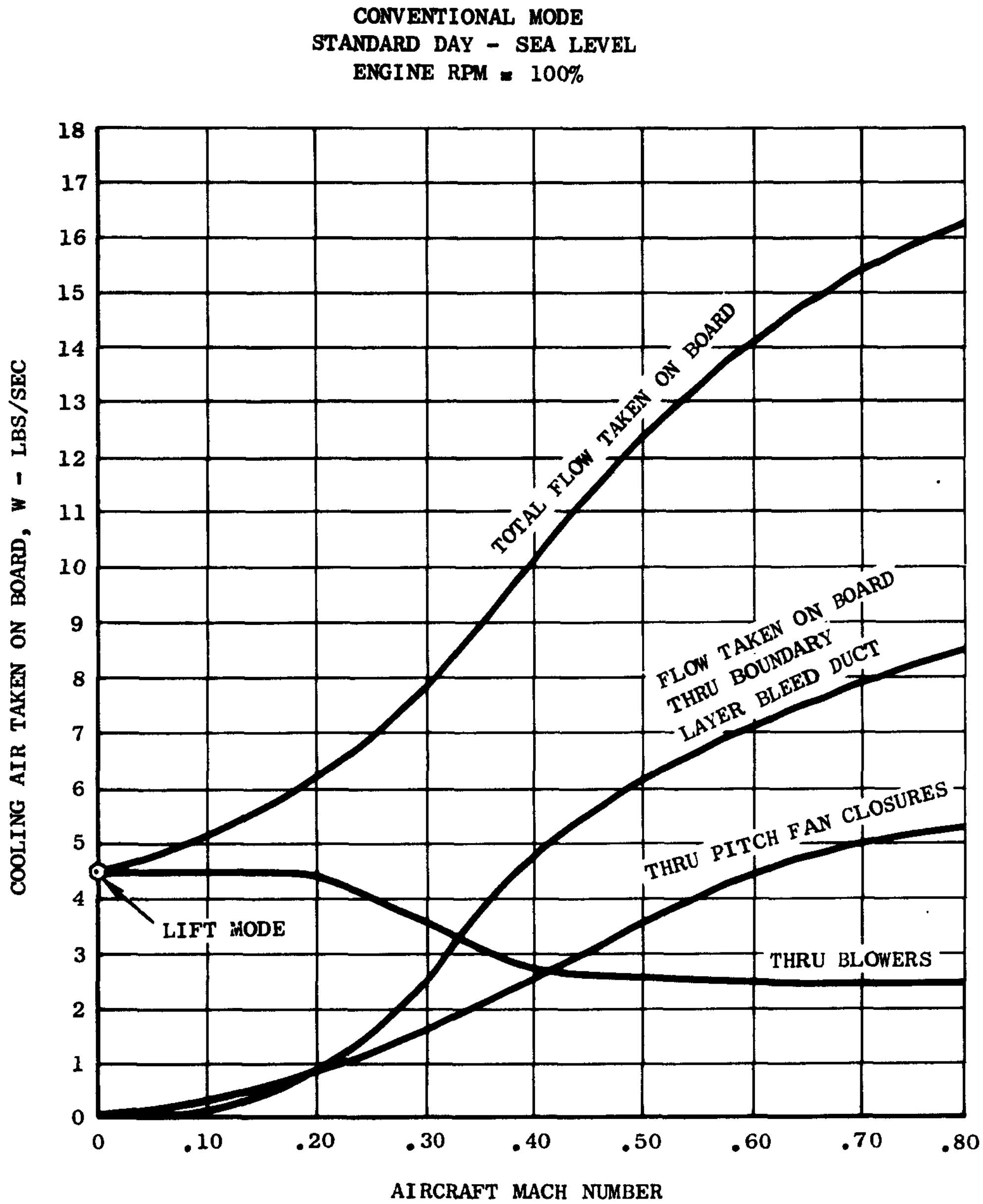

Figure 7 Cooling Air Taken On Board Aircraft - Conventional Mode

*BASED ON 0.8% W_6 DIVERTER VALVE LEAKAGE

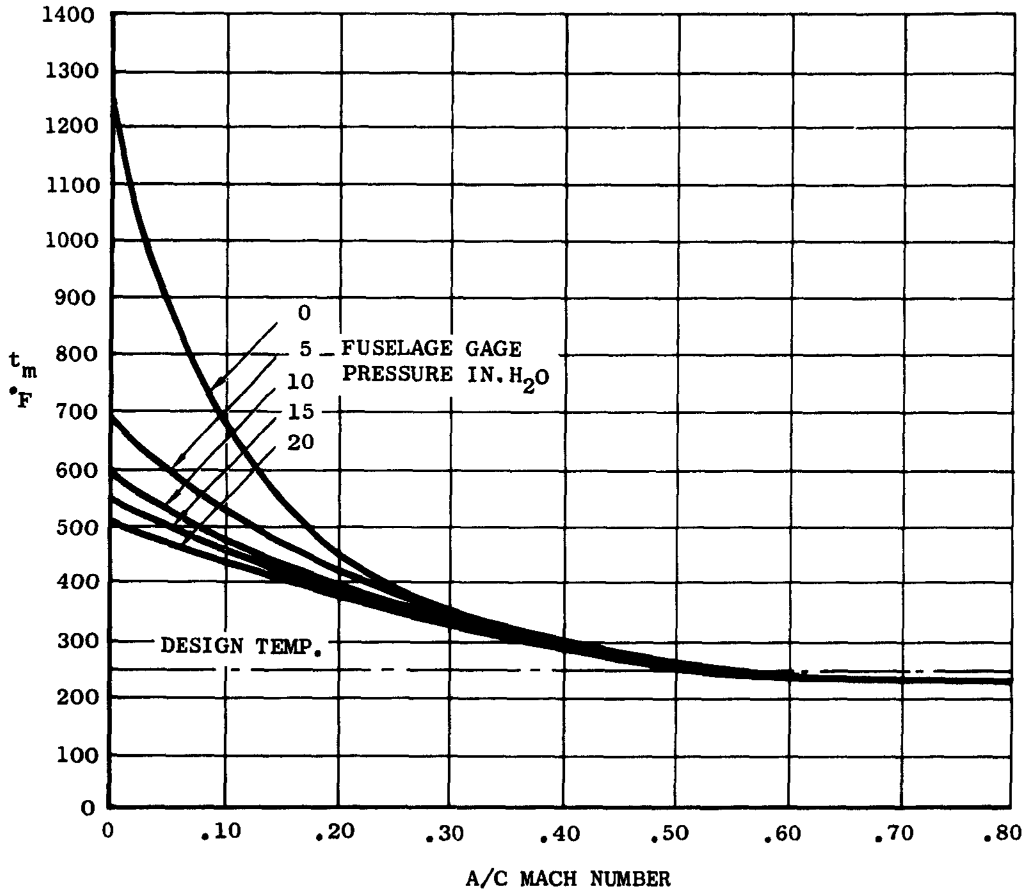

Figure 8 Wing Fan Cavity Inlet Air Temperature* vs Aircraft Speed and Fuselage Pressure

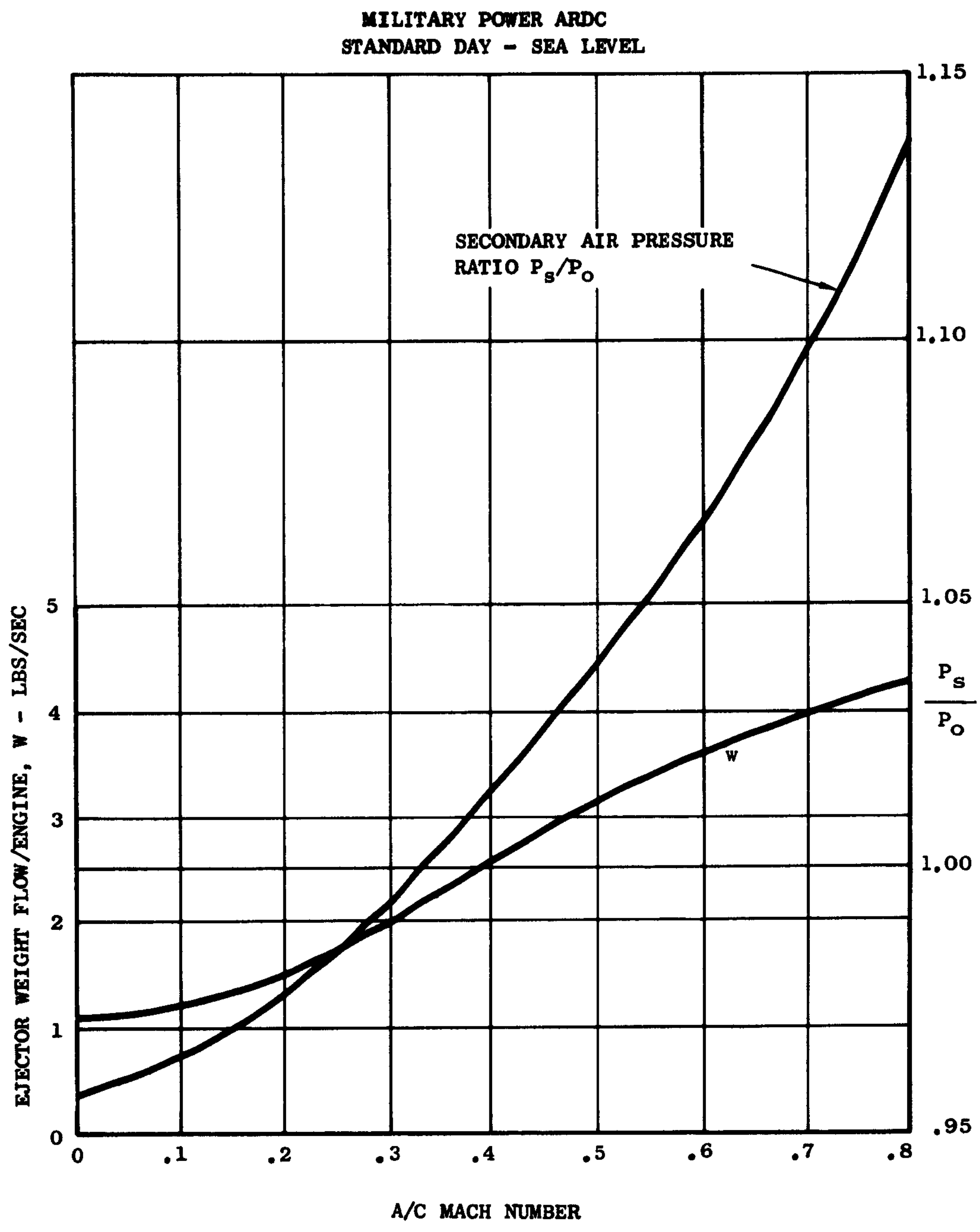

Figure 9 Ejector Performance vs Aircraft Flight Speed

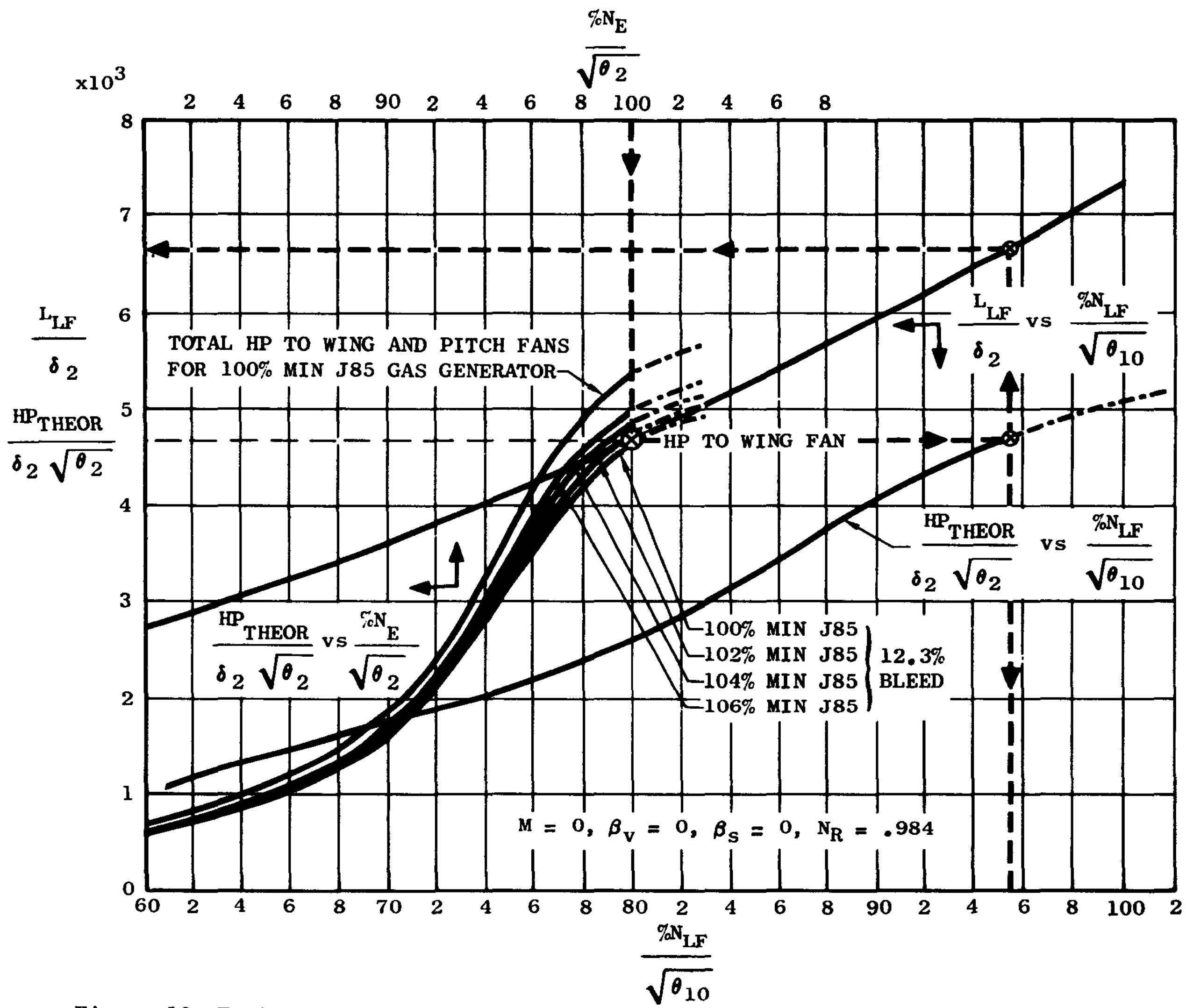

Figure 10 Estimated XV-5A Installed Power Plant Performance - Main Lift Fan Only

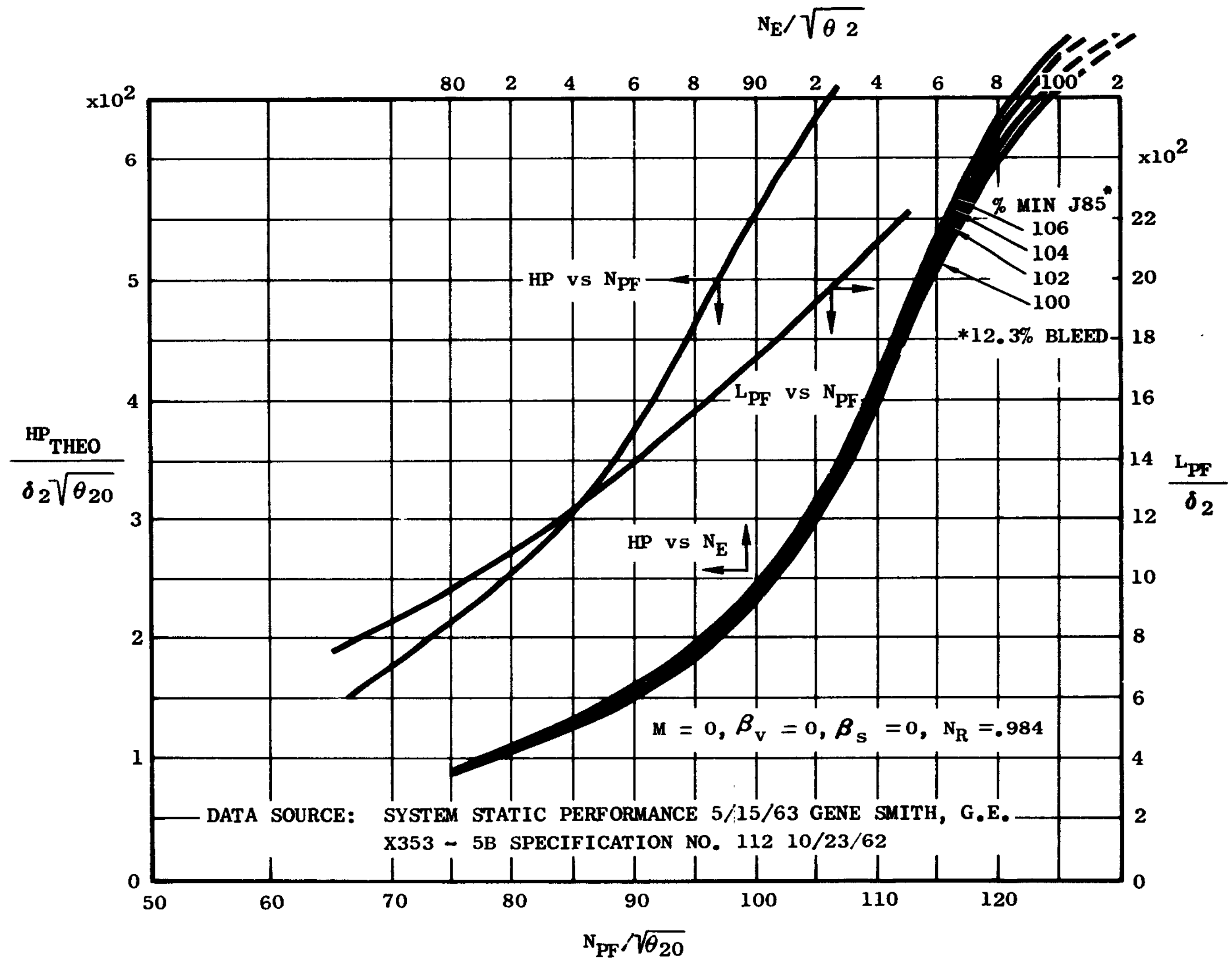

Figure 11 Estimated XV-5A Installed Power Plant Performance, Pitch Fan Only

F. STRUCTURAL AND SYSTEMS DESIGN

1. Progress

With all structural and systems design efforts completed during the last reporting period, most of the effort was shop liaison and detail part redesign due to fit and function problems.

Detail design of the strut located below the pitch fan was completed. This strut will improve the pitch fan negative thrust margin, and will be evaluated during the Ames tests. After the tailpipes were installed, it became apparent that a heat insulation blanket should be provided between the aft fuel tank and the engine tailpipe shroud. This design was completed and incorporated on both airplanes.

The Design Group also supported the hydraulics and controls simulator effort. Items such as the hovering control system frequency response test were witnessed and approved by the Design Group.

2. Schedule

The Structural and Systems Design Group was on schedule at the close of this reporting period.

3. Plans for Continuing

Plans for continuing next quarter include continuation of the liaison effort, and technical support of the ground and flight test program.

G. RELIABILITY

1. Progress

During the last reporting period, the Reliability Group witnessed the completion of the static proof test, ground resonance test, and simulator operation.

The Reliability Group also coordinated with the Test Group, and aided in evaluation of the few remaining vendor equipment items which did not meet all of the specification requirements. Those vendor items which did not meet the specification requirements were evaluated to determine if they could be accepted. Items which were accepted below specification requirements, were determined as not jeopardizing the reliability or functional adequacies of the airplanes' systems.

A sample of the relative functional failure rates analysis being conducted is shown below. Comparative analysis of four alternate configurations of the improved thrust vector actuator function programmer was analyzed. The relative function failure rates of the four configurations analyzed are:

	CONFIGURATION	L_c (BASE)	L_s	RELATIONSHIP	L_t
1.	1 Switch and 1 Cam	L_c	$100L_c$	$L_c + L_s = L_t$	$101L_c$
2.	1 Switch and 2 Cams	L_c	$100L_c$	$2L_c + L_s = L_t$	$102L_c$
3.	2 Switches and 2 Cams	L_c	$100L_c$	$2L_c + 2L_s = L_t$	$202L_c$
4.	2 Switches and 2 Cams	L_c	$100L_c$	$2L_c + \frac{2L_s}{2} = L_t$	$102L_c$

L_c = Cam Failure Rate

L_s = Relative Switch Failure Rate $\cong 100L_c$

L_t = Combination Failure Rate

Configuration 1 is used for conversion control interlocks and thrust vector actuator control. Configuration 4 is used for CTOL/VTOL trim control and throttle cutback control.

Another vendor component studied by the Reliability Group was the horizontal stabilizer actuator. This actuator experienced numerous malfunctions and performance failures during acceptance tests, and during the installed tests on the hydraulics and controls simulator. Some improvements have been accomplished by redesign and rework, however, subsequent tests justify little

confidence that the actuator will meet all performance requirements. On the basis of reliability based upon real-time operating experience, an alternate source was recommended and subsequently selected.

It has been determined that the present horizontal stabilizer actuator meets all expected requirements during the conventional flight mode and the hovering mode up to transition speed. Through actual tests, it was determined that the actuator would not perform adequately during the conversion cycle with one hydraulic system inoperative. The Reliability Group was supported, in its determination that a severe reliability deficiency existed during the conversion sequence, by the Project Office. The second source actuator will be available including a rigorous qualification test prior to the scheduled conversion date.

Inspection of airplane No. 2 after the ground resonance tests revealed two electrical wiring cable mounting clamp failure modes. They were (1), opened clamps; and (2), chafed wire insulation. As a result of these failures, all cable mounting clamps of the type which failed have been replaced in both airplanes with metal cushion clamps. The damaged wire insulation was repaired. The Reliability Group has taken steps to disallow the use of plastic cable mounting clamps on Ryan aircraft, and has taken steps to notify the vendor of the failures experienced with his product on the XV-5A.

The Reliability Group initiated work on the Flight Worthiness Report. A portion of this report will include the final reliability summary based upon real-time reliability data resulting from the hydraulics and controls simulator operation, and experiences gained from both aircraft.

2. Schedule

All reliability milestones were on schedule at the close of this reporting period.

3. Plans for Continuing

Plans for continuing next quarter include, (a) completion of components and systems maintenance and overhauling schedule listing; (b) continued collection and analysis of hydraulics and controls simulator data; (c) continuation of information acquisition for the Flight Worthiness Report.

III. MANUFACTURING

A. FABRICATION

1. Progress

At the end of this reporting period, ship No. 1 was approximately 92 percent complete and ship No. 2 was 94 percent complete for the installed systems ground testing configuration.

Ship No. 2, shown in Figure 12, was released to Engineering test to start the ground resonance testing. Ship No. 1 which was returned from the structural proof test, underwent refurbishing in preparation of installed systems functional tests, prior to release for wind tunnel testing at NASA-Ames. Figure 13 shows ship No. 1 at the end of the last reporting period, returning from static test. Figure 14 shows ship No. 1 at the end of this reporting period.

Two major vendor equipment items presented problems during life cycle qualification testing. The engine driven cooling fan rotor failed during the vendor's endurance runs. The fan-gear box assembly can be seen in Figure 15 just below and forward of the J-85 engine inlet case. The vendor is currently proceeding on a round-the-clock schedule to redesign and qualify replacement rotors. It is anticipated that the rotors will be completed before they are required for engine runs, however, removal of the gear-box assembly; vendor time required to replace the rotors; and reinstallation into the airplane will delay the start of engine runs 1 week.

The other vendor problem is the horizontal stabilizer actuator. Figure 16 shows the vertical stabilizer with the leading edge fairing removed. The actuator can be seen in its rigged position.

This actuator has fallen short of Ryan's specification requirements, and although it possibly could have operated satisfactorily, a decision was reached to procure second source backup actuators. Had this actuator deteriorated any further in performance, the flight test program would have to be discontinued until a qualified replacement could be made available.

The electrical mixer boxes for both ships were completed and checked out satisfactorily, (Figures 17 and 18). The units contain the primary and standby electrical sequencing system plus the failure detection system. The electrical mixer checkout console, Figure 19, was also completed and certified by Ryan Quality Control. It will be used during flight test for periodic inspections.

The auto-stabilization amplifier produced by Ryan Electronics, (Figures 20 and 21) was completed. This amplifier utilizes solid state circuits on plug-in circuit boards as seen with the cover removed in Figure 20. Both standby and primary systems are mounted on a single chassis.

Other major subassemblies completed are shown prior to installation on the aircraft. Figures 22 and 23 show the main and pitch fan mechanical mixer boxes. These units have been installed, and are updated as the result of the last hovering and transition simulation utilizing the mixer box system. The major change was changing β_s (stagger) cams to wash out β_s from 13 degrees to 6 degrees at high exit louver angles. This results in additional forward fan thrust at conversion speeds.

The Fiberglas engine air induction inlet can be seen in Figures 24 and 25. The square to triangular shaped ducts are cooling fan distribution ducts to the engine compartment.

Many fit and function problems came to light during this period as final completion of assembly work and quality control tests were conducted. Close Engineering to Shop coordination resulted in quick solutions. The Manufacturing effort continued on a full two-shift basis, including continuation of the overtime policy.

Ryan Purchasing Department continued to maintain on-vendor-site surveillance of vendors whose parts were returned for rework.

2. Schedule

Ship No. 1 was approximately 1 week behind schedule and ship No. 2 was approximately 4 days behind schedule at the end of this reporting period.

3. Plans for Continuing

Both ships will be released to Engineering Test for installed systems ground testing early in the next quarter. The airplanes will then be shipped to wind tunnel and flight test early in January 1964.

Figure 12 Ship No. 2 Prior to Start of Ground Resonance Testing

Figure 13 Ship No. 1 at the End of Last Reporting Period

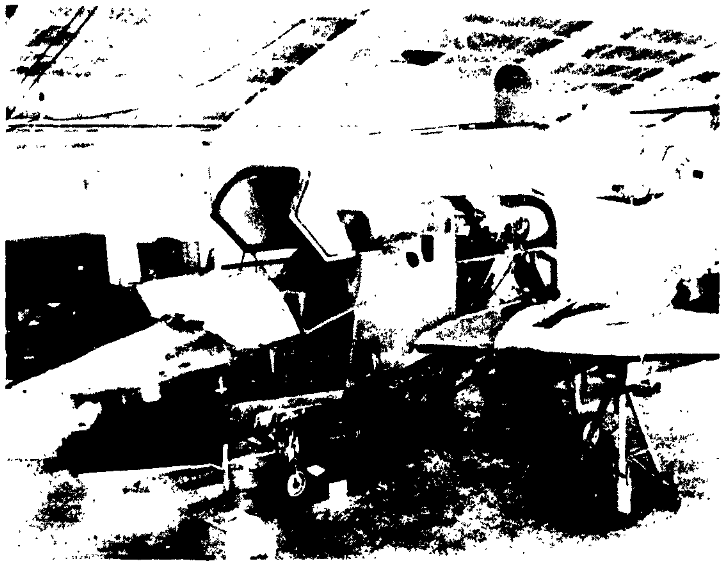

Figure 14 Ship No. 1 at the End of This Reporting Period

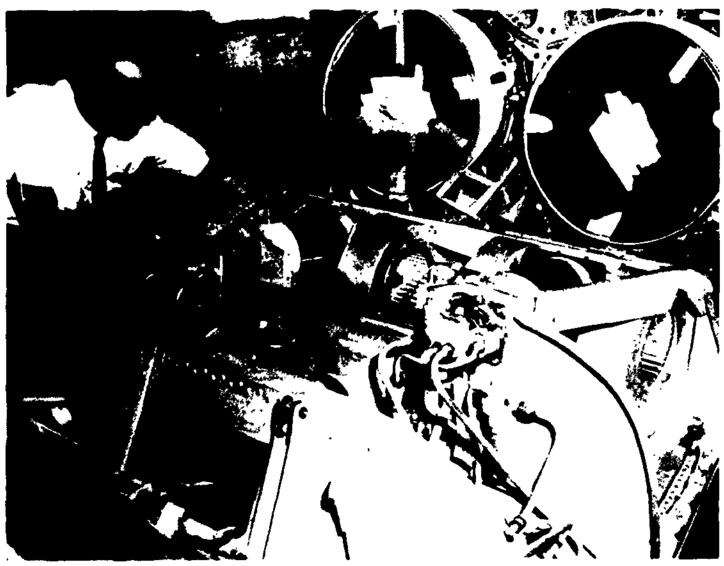

Figure 15 Airplane Equipment Compartment Showing Cooling Fans

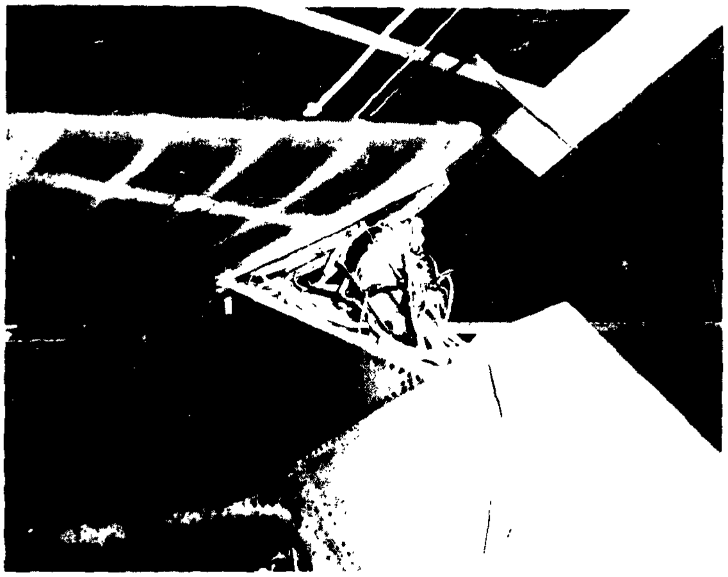

Figure 16 Horizontal Stabilizer Actuator Installation

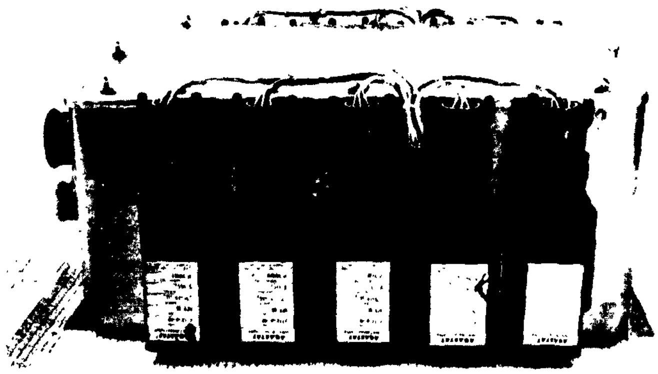

Figure 17 Electrical Mixer Box Assembly

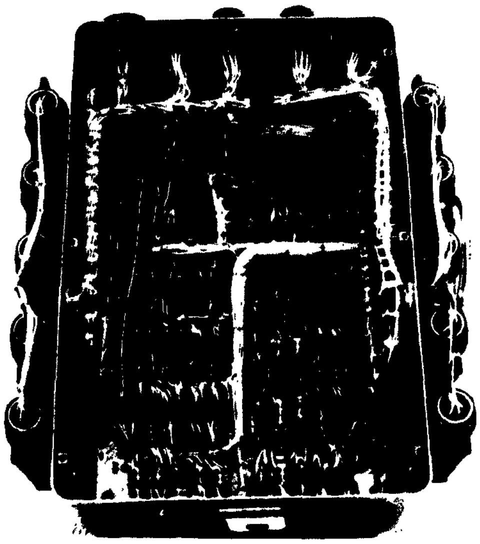

Figure 18 Electrical Mixer Box - Cover Removed

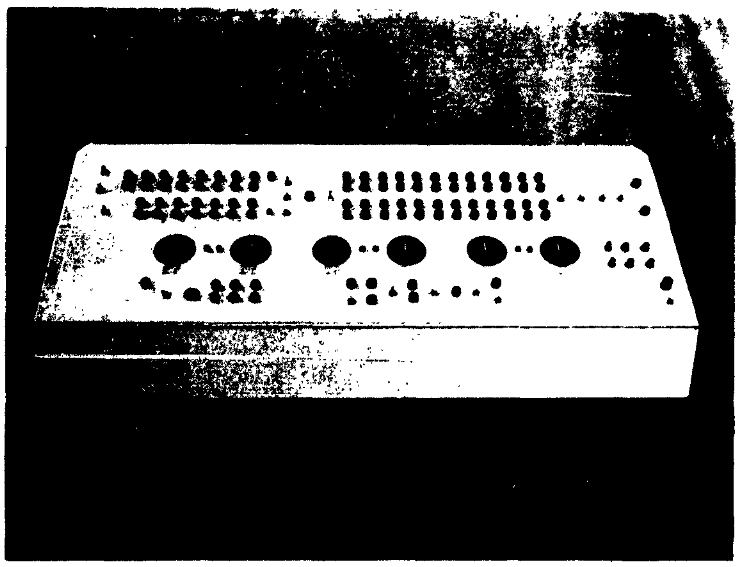

Figure 19 Electrical Mixer Box Check-out Console

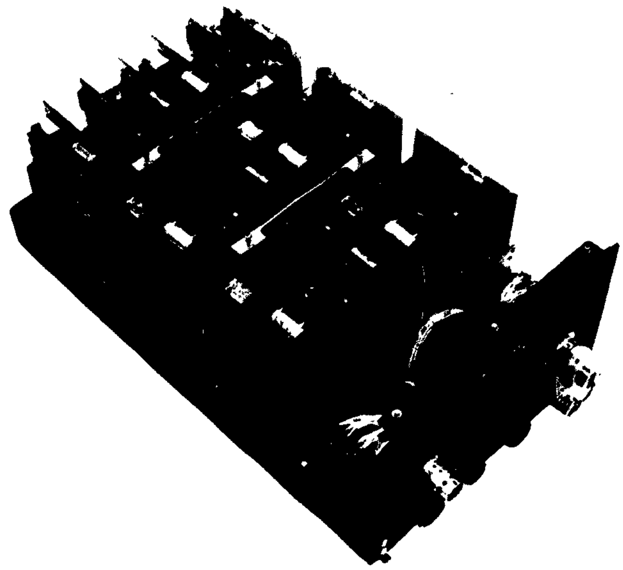

Figure 20 Auto-Stabilization Amplifier - Cover Removed

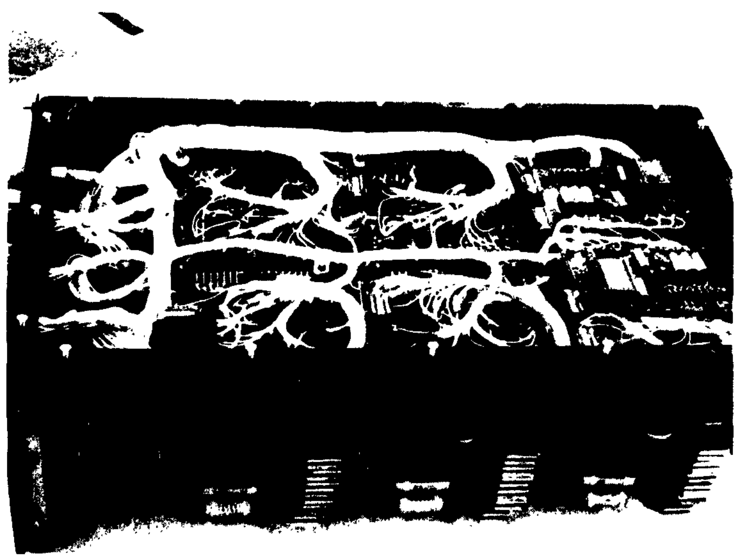

Figure 21 Auto-Stabilization Amplifier - Showing Chassis Configuration

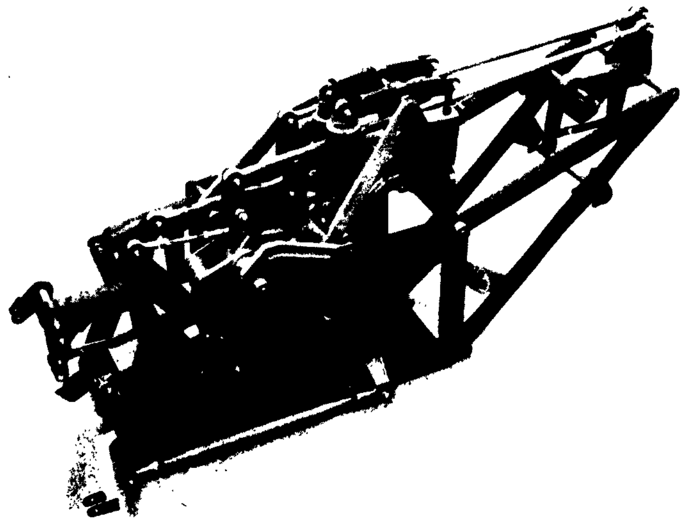

Figure 22 Main Mixer Box - Complete

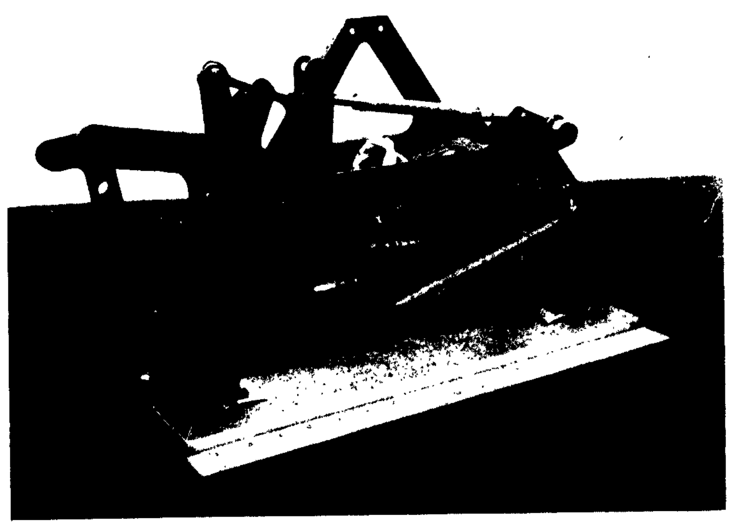

Figure 23 Pitch Fan Mixer Box - Complete

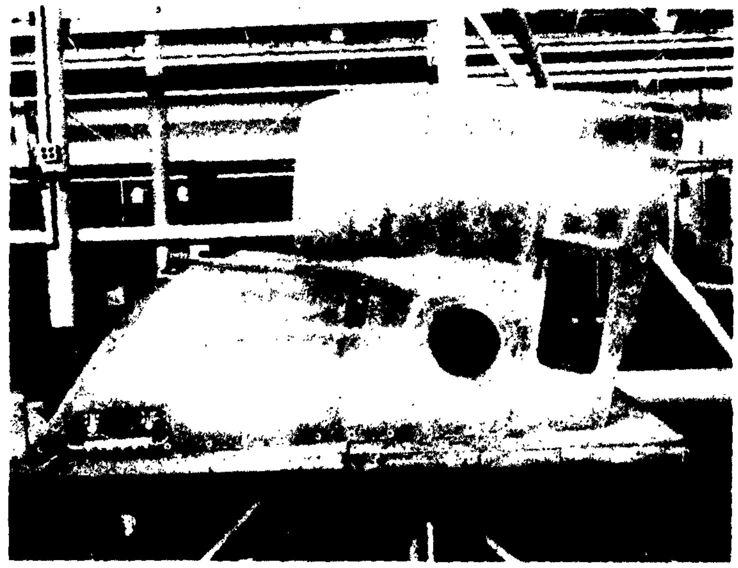

Figure 24 Engine Inlet Cover

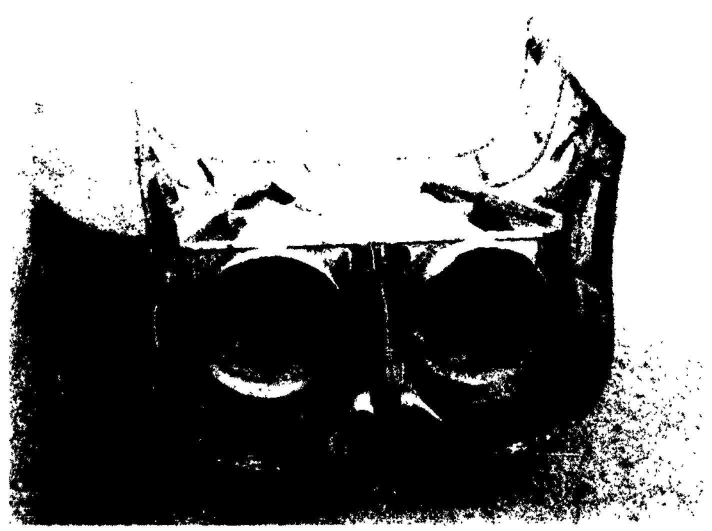

Figure 25 Engine Inlet Cover - Upside Down

IV. GROUND TEST

A. TEST PROGRAM DEVELOPMENT

1. Progress

Component testing was completed during this period, with the exception of retesting vendor equipment items which were returned for rework.

The engine driven cooling fan-gear box assembly was structurally tested at the vendor's factory. While the vendor was conducting life cycle tests, the fan rotor failed. The Ryan Test Group investigated the failure and determined by micrographic inspection that the rotor had been brazed at too high a temperature, resulting in reduced strength of the parent material. Large grain growth resulting from the high temperature reduced the fatigue characteristics to the point of failure. New redesign rotors were in work at the end of this period.

The fan-gear box assembly was vibrated at Ryan and a resonant freqency of the fan scroll resulted within the operating spectrum, (Figure 26). Stiffeners were added to raise the fan scroll resonant frequency, and retests were successful.

Fan-gear box performance tests were conducted at the Ryan plant, (Figures 27 and 28). Fan efficiency was above specification requirements, resulting in 1 horsepower less than was anticipated at maximum speed.

With the static structural proof test completed at the Convair facility, the remaining test of the wing fan door was successfully conducted. A simulated high speed, 4 g load condition was applied using whiffle trees for loading and an actual fan to react the loads, (Figure 29). Door open simulated loads were applied using shot bags to test the most critical fan operating case, during transition speed while yawing, (Figure 30).

The Final Structural Proof Test Report was 20 percent complete at the close of this reporting period. This report will compare static structural proof test results with structural analysis data.

Ground test instrumentation design and fabrication was completed and 90 percent installed in both aircraft. The signal conditioner box fabrication (Figure 31), was completed. The signal conditioner conditions the various transducer signals so they can be accepted by the Pulse Code Modulation In-Flight Recording System.

The photo panel, (Figures 32 and 33) was completed. It will be utilized to measure cooling system flow velocities. This unit will be used during flight

in the early portion of the Flight Test Program. When the cooling system is qualified, the photo panel will be permanently removed, along with extra temperature recording equipment, thus reducing the instrumentation weight by 104 pounds.

Prior to commencement of ground vibration testing, ship No. 2 was positioned on scales and weighed, Figures 34 and 35. The airplane was fueled and de-fueled to determine weight of trapped fuel. This also served to test the fuel boost pump system.

The Ground Test Group completed and issued the Installed Systems Test Procedure, Ryan Report 63B102. This report details test procedures for testing all airplane subsystems for proper function and inter-system compatibility prior to release of the airplane to flight test.

The Hydraulic and Controls Simulator was completed and is in operation at the close of this quarter, (Figures 36 and 37). Approximately 30 hours of run time on the hydraulic system had been accumulated. Real-time component cycling and run time is being recorded as a part of the Reliability Program. Several minor problems have occurred and corrected on the simulator, as well as on the airplane.

After cycling, the wing fan door attach bracket started to gall with the fan mounted bracket. Readjustment of the fan door bracket tolerances resolved this problem.

Another problem identified was the Teleflex cable which resembles an automobile choke cable. This cable coordinates the pitch fan mixer and main mixer box. The cable is designed to carry in excess of a 100 pound load, although the maximum service load is approximately 6 pounds. Even with this large margin, the cable on the simulator failed. An investigation revealed that the cable strands started to unwind, and caused high friction loads between the cable and its outer sleeve. A redesigned unit is on order and will be incorporated into the simulator and both ships. No other items of significance have been found after approximately 30 hours of hydraulic and controls simulator operation.

The Ground Resonance Test, (Ryan Report 63B086), was essentially completed during this period. The purpose of the ground resonance test, (Figures 38 and 39), is to establish the actual vibration modes of the XV-5A aircraft, and the resonances of airplane components. This test data will be used for confirmation of the preliminary modal characteristics obtained through the use of analytical techniques. Since the flutter investigations of the XV-5A completed to date have been based upon analytical and flutter model tests, the structural model being of necessity idealized, the experimentally determined mode shapes, in addition to other experimental data, will determine the validity of previous investigations.

The ground vibration test was divided into 3 phases. Each phase investigated different characteristics of the aircraft and its components. The first phase determined the overall vibration characteristics of the airplane, i.e. resonant structural frequencies, mode shapes, and structural dampening. The second phase placed emphasis on obtaining the vibration characteristics of the individual components of the aircraft, such as control surfaces, flaps, fan doors, etc. The third phase experimentally determined the rotational stiffnesses of all irreversible control surfaces. This phase involved determining the roll and yaw stiffnesses of the horizontal stabilizer pivot points. In addition to the above phases, impedance measurements were made for the aileron system.

At the close of this period, all tests were completed except for determining vibration characteristics of the fan doors, thrust spoiler doors, ailerons and elevators. This last effort will be completed by November 26, 1963.

Modal data and establishment of airplane resonances was acquired by the use of accelerometers and potentiometers. The locations of the accelerometers and potentiometers were positioned as dictated by the specific test being conducted. Typical shaker installation is shown in Figures 40 and 41. Eight electromagnetic shakers were required for the basic vibration tests. Force input was controlled from a console, shown in Figure 42. During the resonant testing, the wing fan and nose fan vibratory force levels were monitored to insure a safe force level on the fans, (Figure 43). Oscilloscopes were used as a visual reference, and data recording was by use of X-Y plotters and fast delivery time oscillograph recordings, Figures 44 and 45.

During the airplane resonance test, the Structural Dynamics Group performed preliminary data reduction to insure that the data was satisfactory before proceeding to the next test.

The aircraft suspension system, shown in Figure 46, utilized bungee cords to isolate the aircraft while determining vibration modes of the aircraft. The spring mounted platforms held the aircraft in level flight attitude, and allowed the shakers to produce the highest rigid body frequency, by limiting the suspension system's natural frequency to 2.5 cycles per second.

2. Schedule

The Ground Test Program was on schedule at the end of this reporting period.

3. Plans for Continuing

Plans for continuing the next quarter include completion of the ground vibration component testing by November 26, and completion of the installed systems tests on both aircraft prior to aircraft shipment.

Figure 26 Fan-Gear Box Vibration Test

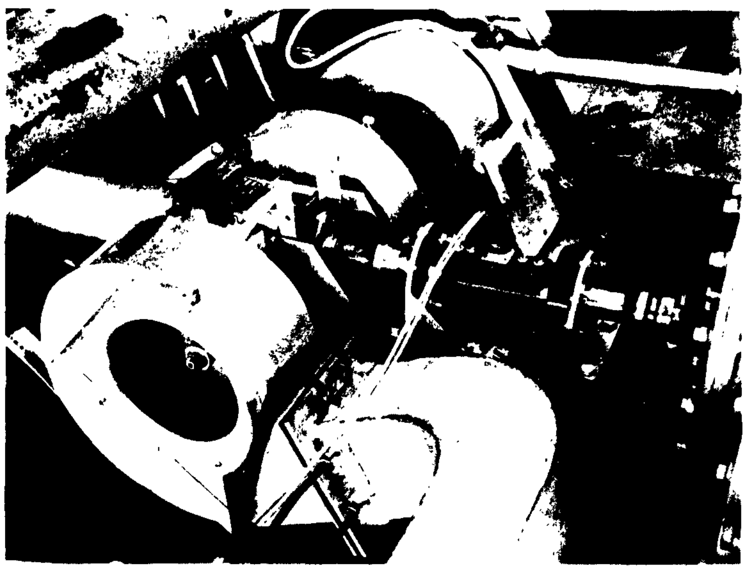

Fig. 27 Fan-Gear Box Performance Test
Rig Showing Torque Transducer

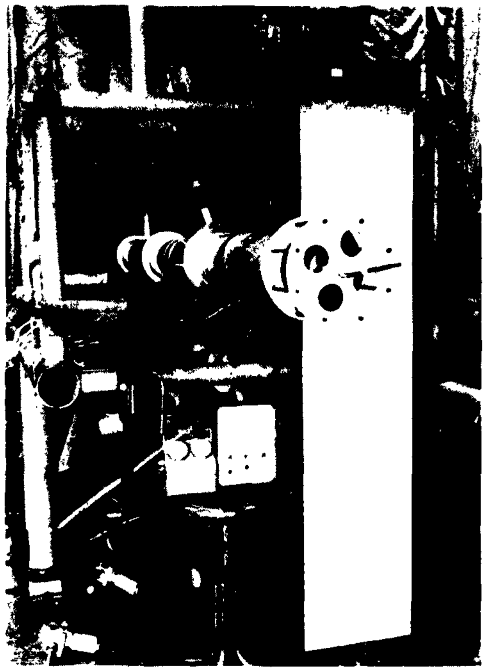

Figure 28 Fan-Gear Box Performance Test Rig Showing Flow Measuring Duct and Manometer Board

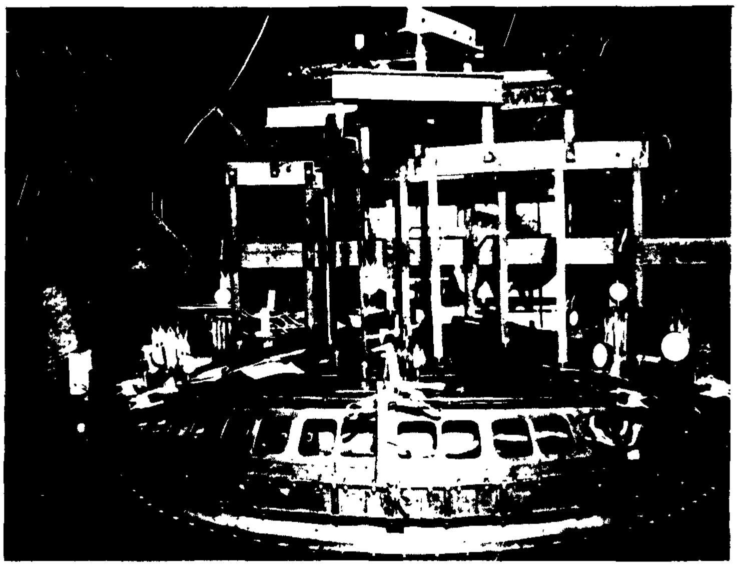

Figure 29 Fan Closure Door Structural Proof Load of Door, Latches, and Fan - High Speed 4g Flight Condition

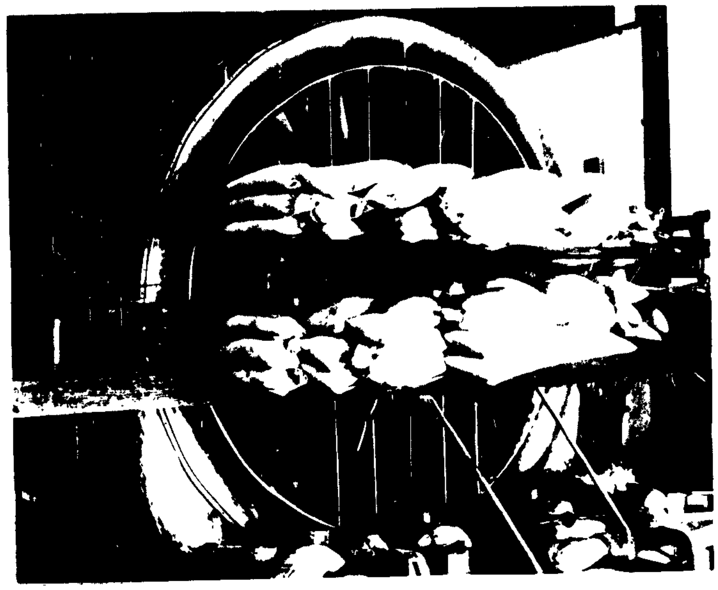

Figure 30 Fan Closure Door Structural Proof Load - High Speed Fan Powered With Yaw Condition

Figure 31 Signal Conditioner Box - Cover Removed

Figure 32 Photo Panel Assembly

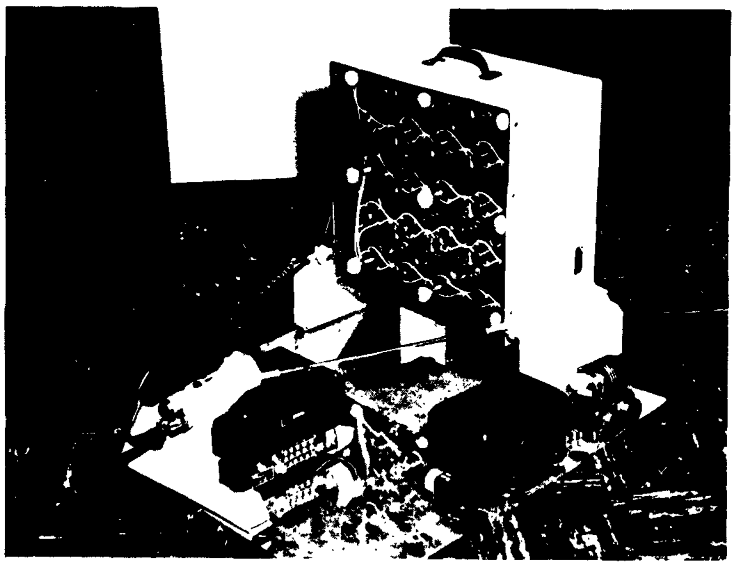

Figure 33 Photo Panel With Bonnet Removed

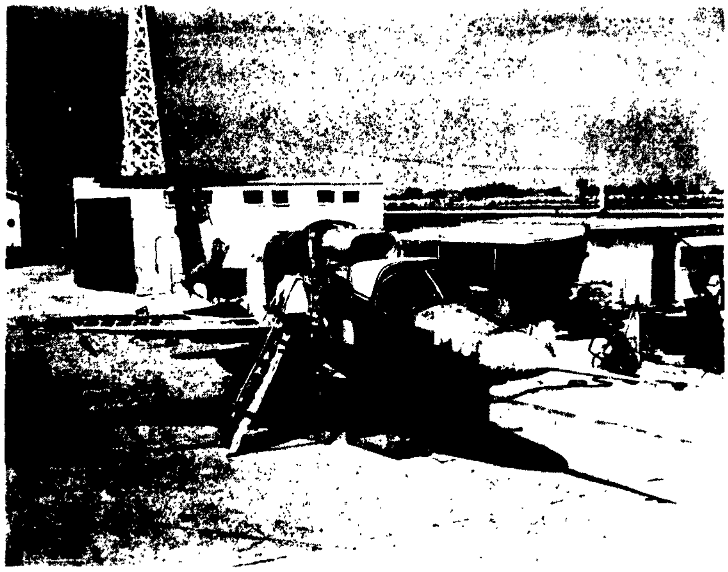

Figure 34 XV-5A Fuel Remaining Weight Measurement

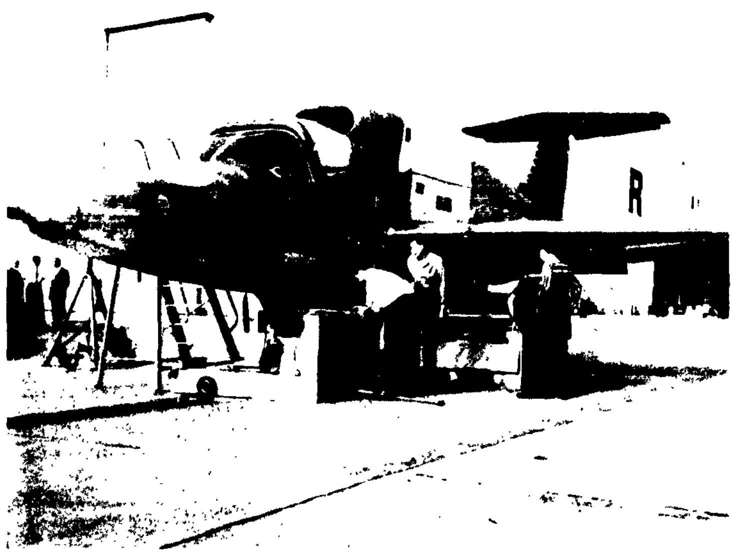

Figure 35 XV-5A Weighing in Before Ground Resonance Tests

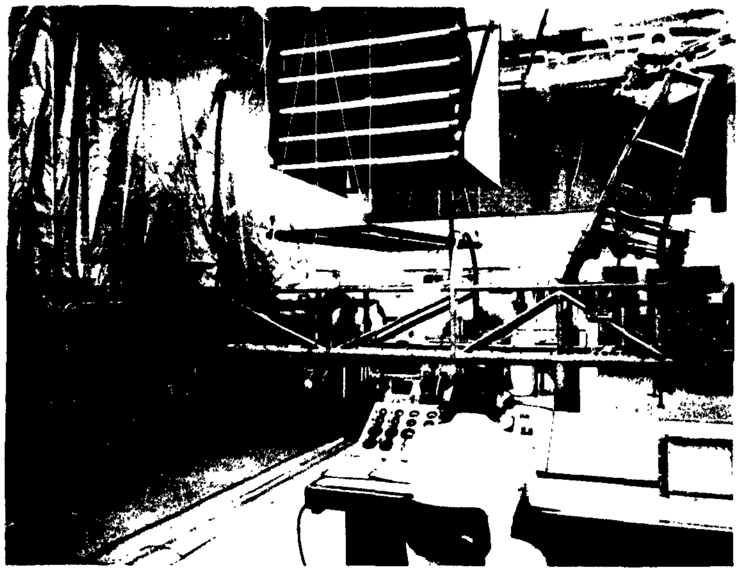

Figure 36 Hydraulic and Controls Simulator

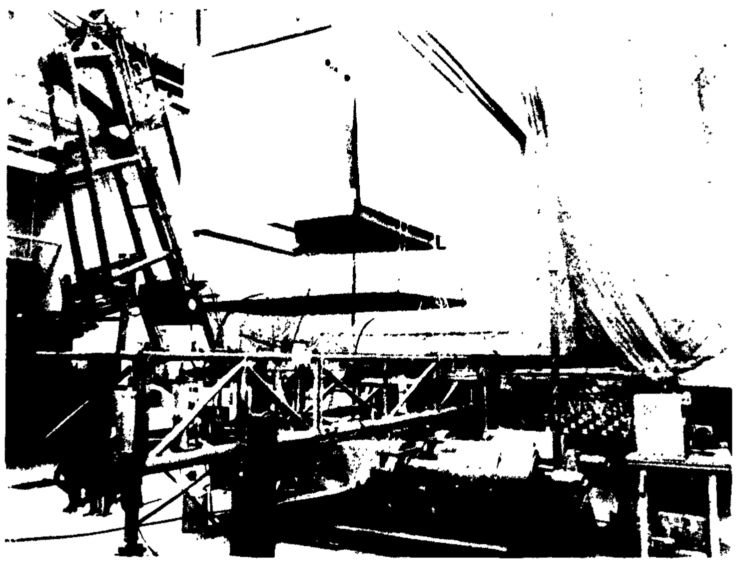

Figure 37 Simulator Drive System

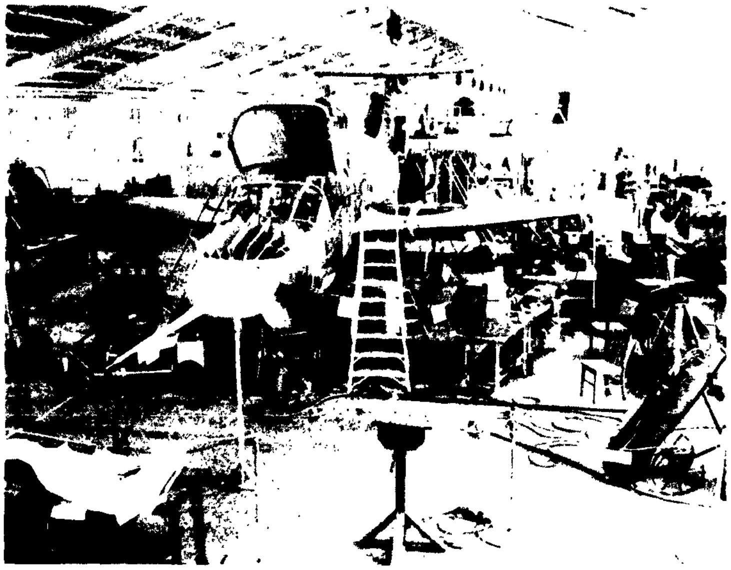

Figure 38 Ground Resonance Test Area Showing No. 2 Airplane With Test Equipment

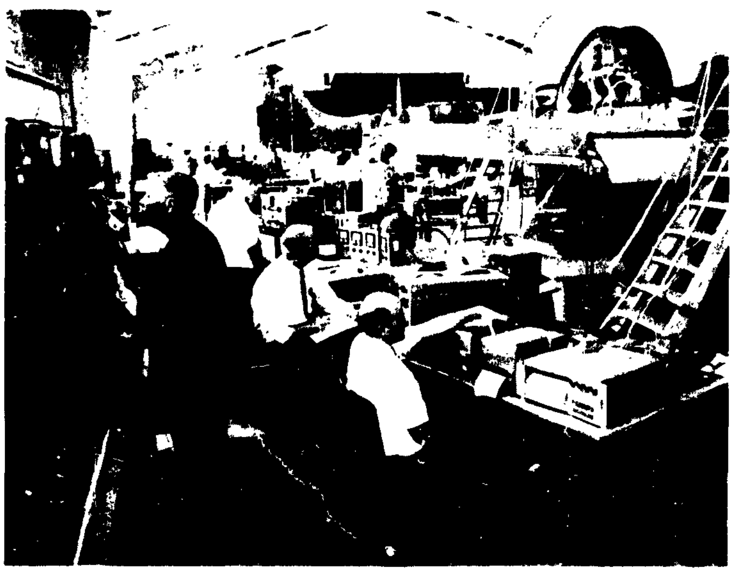

Figure 39 Ground Resonance Data Recording Grouping

Figure 40 Shaker Installed at Horizontal Stabilizer

Figure 41 Shaker Installed at Vertical Stabilizer

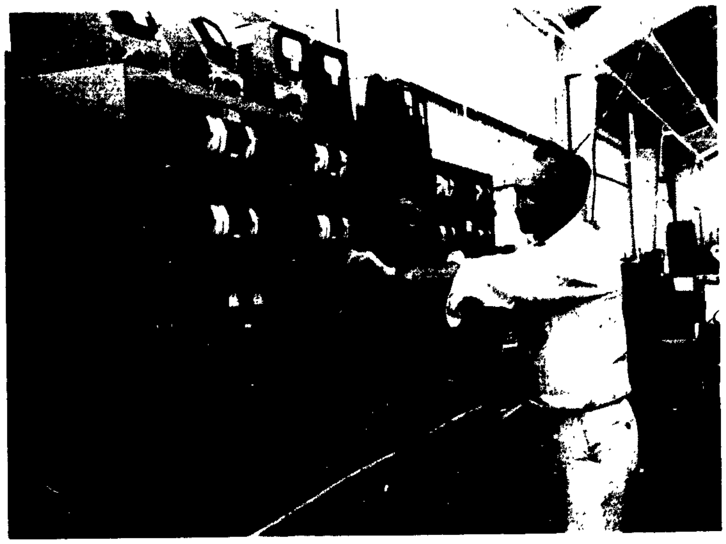

Figure 42 Shaker Force Input Controller

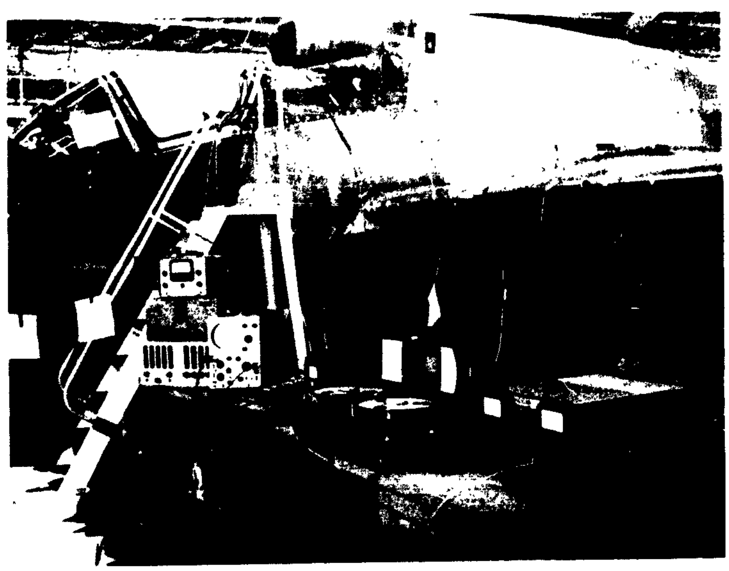

Figure 43 Fan Vibration Recording Equipment

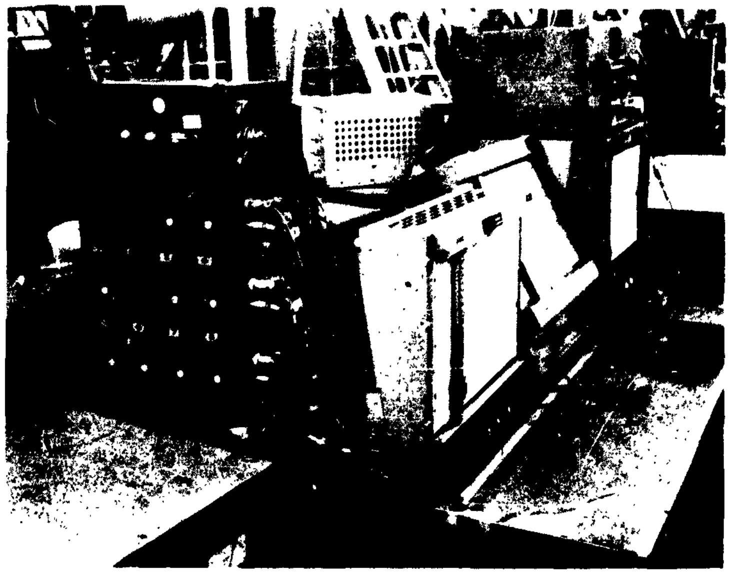

Figure 44 X-Y Plotter

Figure 45 Ground Resonance Recorder

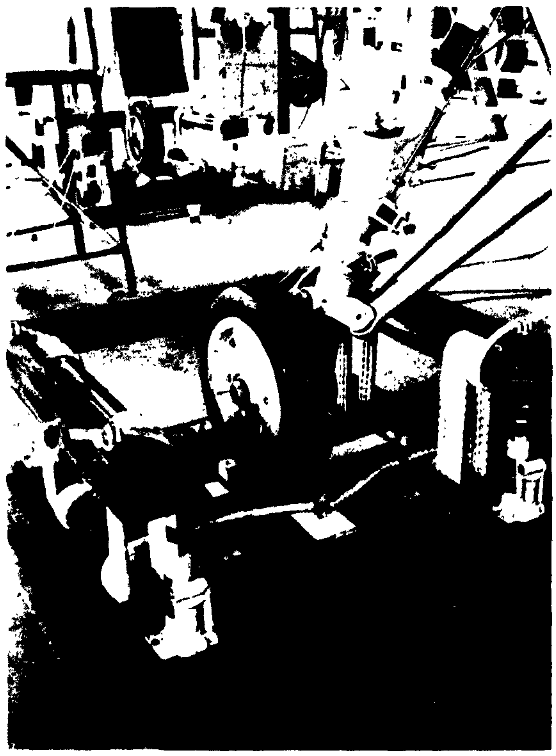

Figure 46 Ground Resonance Airplane Support System

V. FLIGHT TEST

A. TEST PROGRAM DEVELOPMENT

1. Progress

With all flight instrumentation design completed last quarter, the Flight Test Design Group coordinated the installation of instrumentation into both airplanes. All instrumentation was installed in both aircraft ready to receive the Pulse Code Modulation System. The photo panel recorder and signal conditioner were trial fitted in airplane No. 2.

Coordination with the General Electric Flight Test Facility continued. Actual dates and time required for all support equipment was being determined for presentation to General Electric.

The Detail Flight Test Plan, Ryan Report 63B001, was submitted for approval. This plan details the program presented in the Basic Flight Test Program Plan, see Ryan Report 62B090.

The Flight Test Group accumulated engineering data which will be required in support of the flight test program. This data will be collated and compiled into a ready reference file.

Both test pilots, being helicopter and fixed wing qualified, obtained additional flight experience in fixed wing and rotary wing aircraft during this reporting period. Both pilots have been involved with the simulator buildup and checkout, and will accomplish the final flying qualities evaluation of the hover and transition mode by mid-December, 1963.

2. Schedule

The Flight Test Program effort was on schedule at the end of this reporting period.

3. Plans for Continuing

a. Plans for continuing next quarter include participation in final ground tests preparatory to start of flight test.

b. Further flight proficiency training for both pilots.

c. Simulator evaluation of the hover, transition, and conventional mode airplane handling qualities.

d. Movement of all flight test personnel, equipment, and ship No. 2 to Edwards Flight Test Center to commence the Flight Test Program.

VI. MILESTONE COMPLETION SUMMARY

Number	Milestone	Planned Date	Actual Date	Anticipated Date
75	Complete static structural tests of complete airplane	8-20-63	8-20-63	
72	Complete fabrication of major test fixtures and equipment for component test program	9-12-63	9-12-63	
63	Complete installation of basic flight test instrumentation in #2 aircraft	9-23-63	9-23-63	
83	Submit detailed flight test plan for approval	10-22-63	10-21-63	
77	Complete ground resonance test No. 2 aircraft	10-31-63	10-28-63	
66	Complete all component integrity and reliability tests	11-1-63	11-1-63	

VII. VISITS TO GOVERNMENT AGENCIES

DATE	FACILITY VISITED	PURPOSE
10-4-63	Headquarters Mobility Command	XV-5A Technical Briefing
11-21-63	Edwards Air Force Test Center	Coordinate Flight Test Program